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Report of the

CONFERENCE ON AQUACULTURE IN THE THIRD MILLENNIUM

Bangkok, Thailand, 20-25 February 2000

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2001

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ABSTRACT

The Conference on Aquaculture in the Third Millennium (the Bangkok Conference on Aquaculture) was held on 20-25 February 2000 in Bangkok, Thailand, for the purpose of developing a strategy for aquaculture development in the next 20 years. It was a sequel to the Kyoto Conference on Aquaculture, which was organized by FAO in May-June 1976. The Bangkok Conference was attended by 549 participants representing all stakeholder groups in aquaculture. The participants were members of more than 200 organizations and came from 66 countries in Asia, Africa, Latin America and the Caribbean, Europe, the former Soviet Republics, the Near East, North America, and Oceania. The list of participants appears as Annex 3.1.

The Bangkok Conference crafted the document Aquaculture Development Beyond 2000: the Bangkok Declaration and Strategy, which has been published separately by NACA/FAO[1]. The Declaration addresses the role of aquaculture in alleviating rural poverty, improving livelihoods and food security, and maintaining the integrity of natural and biological resources and the sustainability of the environment. The Strategy comprises 17 elements that focus on measures that governments, the private sector and other concerned organizations can incorporate into their development programmes for the aquaculture sector. It highlights the need for regional and interregional cooperation to assist in its implementation.

This Report of the Bangkok Conference on Aquaculture, the second publication arising from the Millennium Conference, includes the detailed recommendations of the fourteen thematic conference sessions. The third publication will be the Technical Proceedings of the Bangkok Conference.

The Bangkok Conference was organized by NACA and FAO and hosted by the Government of Thailand. It was held at the Central Plaza Hotel in Bangkok, along with the Aquaculture and Seafood Fair 2000, which was seen by more than 3000 visitors.

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[1] NACA/FAO. 2000. Aquaculture Development Beyond 2000: the Bangkok Declaration and Strategy. Conference on Aquaculture in the Third Millennium, 20-25 February 2000, Bangkok, Thailand. NACA, Bangkok and FAO, Rome. 27 p.

ACRONYMS AND ABBREVIATIONS

AIT	Asian Institute of Technology
CIDA	Canadian International Development Agency
CCRF	Code of Conduct for Responsible Fisheries
DANCED	Danish Center for Environment and Development
DANIDA	Danish International Development Agency
FAO	Food and Agriculture Organization of the United Nations
ICLARM	International Center for Aquatic Resource Management
LIFDC	Low-Income Food-Deficit Country
MRC	Mekong River Commission
NACA	Network of Aquaculture Centres in Asia-Pacific
NGO	Non-Governmental Organization
OIE	Office International des Épizooties (World Organisation for Animal Health)
SEAFDEC-AQD	Southeast Asian Fisheries Development Center – Aquaculture Department
SPC	South Pacific Commission
SPS	Sanitary and Phytosanitary Agreement
TDC	Technical Drafting Committee
UNDP	United Nations Development Programme
WAS	World Aquaculture Society
WTO	World Trade Organization

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1 REPORT

1.1 Background

Two milestone events in the recent history of aquaculture are the FAO Technical Conference on Aquaculture, held in Kyoto, Japan in 1976, and the Conference on Aquaculture in the Third Millennium, held in Bangkok, Thailand in February 2000. Both aimed to envision the future opportunities and roles of aquaculture in society and to recommend strategies to meet expectations and demands for sustainable aquaculture development in the next two - three decades. The Kyoto Conference looked into the opportunities provided by technology and science, and the possibilities for networking, manpower development and institutional strengthening for aquaculture development.

In addition to these aspects, the Bangkok Conference examined the role that aquaculture will play within the overall context of development, from the local to the global level. The Kyoto Conference adopted two broad strategies: to bring science into aquaculture, which was until then largely traditional, and to expand aquaculture development through regional Cupertino. These strategies were translated into policy and action by governments, with the initial assistance of various multilateral and bilateral agencies.

The rationale for the Bangkok Conference was that, 24 years having passed since Kyoto, it was time to reassess the direction that aquaculture development was taking and to develop strategies to facilitate its sustainable growth.

1.2 Objectives

The Bangkok Conference was designed to continue the work started in Kyoto, with the objective of developing a strategy to facilitate the sustainable growth of the sector and harness its potential contribution to greater social development.

As with Kyoto, the results are intended to assist government policy makers and other stakeholders concerned with aquaculture development to meet the social, technical and regulatory needs of aquaculture over the next 20 years.

Furthermore, the conference was designed to provide the opportunity for more stakeholders to participate in this process, and to discuss the opportunities and functions of modern-day technologies in the development of sustainable aquaculture. To achieve these purposes, the conference:

- envisioned the likely state of aquaculture in the first 20-30 years of the new millennium,
- identified possible constraints to the future development of the sector, and
- recommended strategies to solve these constraints, with emphasis on regional and global Cupertino.

1.3 Organisation

1.3.1 Preparatory Activities

The major inputs to the conference were developed via a number of focused and intensive preparatory activities designed to achieve global coverage and comprehensive review of all the relevant issues. These included:

- the regional workshop to formulate the Asian aquaculture development strategy for 2000-2020, conducted by NACA in Kanchanaburi, Thailand in September 1999;
- a review of South Pacific aquaculture conducted by the Secretariat of the Pacific Community (SPC) with the assistance of ICLARM;

- the reviews on the state of, and trends in, aquaculture development in five other regions, namely, Sub-Saharan Africa, Latin America and the Caribbean, Europe, the former Soviet Republics, the Near East and North America, that were facilitated and supervised by FAO;
- the experts-led 14 thematic reviews of the entire range of policy, legal and technological issues related to sustainable aquaculture development;
- a global synthesis workshop, held at the FAO Regional Office in Asia-Pacific in October 1999, that discussed the regional reviews of aquaculture development trends and synthesised these, along with other information, into a global review on the state of, and prospects for, aquaculture development;
- the preparation of two keynote papers, one to review the development of aquaculture since the Kyoto Conference on Aquaculture in 1976, the other to assess the global prospects for aquaculture development in the next 20-30 years; and
- the development of five plenary lectures by experts aimed to broadly place the themes and issues in context.

Additionally, technical and experience papers were submitted voluntarily, most of which were presented as posters.

1.3.2 Programme

Dr. Rohana Subasinghe of FAO provided an introduction to the background, objectives, strategies adopted, activities and expectations of the conference. As it was an agenda-setting strategic exercise, the Conference Program (see Annex 3.2) was structured so that there were, at most, only two days of parallel sessions, and each session following logically from the previous one. The parallel sessions were the six thematic sessions covering policy and the six sessions addressing technical issues. This was designed to promote greater interaction and wider participation in the discussion of issues associated with the biological, technical, social, economic, environmental, policy and legal aspects of the development of aquaculture.

The Conference Program indicates a deliberate, participatory and iterative procedure that allowed every participant an ample opportunity to contribute constructively to the discussions and the framing of the Declaration and Strategy. The various sessions developed conclusions and recommendations pertaining to the themes discussed, which were synthesised by the Technical Drafting Committee (TDC) into a draft Declaration and Strategy. This draft document was discussed and adopted, in principle, during the final plenary session. The TDC, with assistance from the Conference Secretariat, additionally incorporated relevant comments and suggestions made during this final plenary discussion and those submitted over the one-month period after the conference.

The conference offered broad-based participation and wide-ranging involvement of stakeholders in its planning, preparation, development and conduct, marked by transparency of the entire process, to achieve a high credibility for its results.

Inaugural Ceremony

The inaugural ceremonies of the conference, as well as the Aquaculture and Seafood Fair 2000, were held on the afternoon of 20 February. Welcoming words, acknowledgements and expressions of gratitude to participants and their organisations, governments, sponsors of the conference, and individuals and institutions that rendered assistance to the conference and the activities leading up to it, as well as assurances of commitment to the recommendations of the conference, were spoken by the representatives of NACA and FAO and the host government ORGANISATION. The welcoming speeches of NACA Co-ordinator, Mr. Hassanai Kongkeo, FAO/RAP Officer-in-Charge, Mr. Dong Qingsong, NACA Governing Council Chairman, Mr. A.M. Jayasekara, and Thailand's Director General for Fisheries, Mr. Dhammarong Prakobboon appear as Annexes 3.3 to 3.6, respectively.

The Inaugural Speaker was the Minister of Agriculture and Co-operatives of Thailand, Mr. Pongpol Adireksan. Using the aquaculture development status, prospects and aspirations of Thailand to underpin his message, he outlined the policy and technological requirements that the country would need to sustain its ability to continue to provide food and good livelihoods to the rural people and to improve the economy of the nation. He urged the conference participants to come up with a practicable set of recommendations. The Minister's inaugural address appears as Annex 3.7.

Aquaculture and Seafood Fair 2000

The Bangkok Conference was organised together with the Aquaculture and Seafood Fair 2000 to focus on the participation of the private sector in the development of aquaculture and its allied industries. It also provided an opportunity for members of the aquaculture business and industry sector to interact with policy makers and members of the scientific community, enabling them to learn of international, regional and national policies related to aquaculture and the possibilities that science and technology offer to assist them in developing appropriate strategies. The fair was inaugurated jointly by the Minister of Agriculture and Co-operatives of Thailand, Mr. Pongpol Adireksan, the Minister of Fisheries and Aquatic Resources Development of Sri Lanka, Mr. Mahinda Rajapakse, and the Vice Minister of Fisheries of Vietnam, Dr Nguyen Viet Thang.

1.3.3 Outputs

Declaration and Strategy

The first major output of the Conference is Aquaculture Development Beyond 2000: the Bangkok Declaration and Strategy. The Declaration encapsulates the vision of the conference and the principles and practical considerations upon which the vision is based, and the Strategy describes 17 key elements that countries can incorporate when developing strategies for aquaculture development for the next 20 years.

The draft Declaration and Strategy was presented for discussion and adoption on the afternoon of the final day of the conference. It had been circulated two days earlier to the participants for their comments and suggestions, with the request that these be given in writing or made during the plenary discussion. Twenty-eight lengthy, detailed and unanimously constructive comments from individuals and groups comprising a coalition of international, regional and national Non-governmental Organisations (NGOs) were received between the time the draft was circulated and its presentation in plenary.

Mr. Glenn Hurry, Co-Chairman with Mr. Chen Foo Yan, of the Technical Drafting Committee (TDC), presented the Declaration and Strategy. He said the committee abided by the guideline suggested by the Inaugural Speaker, the Minister of Agriculture of Thailand, which was that the outcomes should be practicable, workable and understandable to the people who have to implement them. He admitted that developing a broadly acceptable text required a degree of compromise and conciliation from all the participants. He emphasised that the key issues and broad strategic directions have been incorporated to provide the framework within which individual countries can tailor their own plans for the development and integration of aquaculture. He stressed that the Declaration must be strong enough to address the key issues confronting the future of aquaculture, because a mediocre document with a weak approach that avoids issues would not give aquaculture a sustainable future.

The TDC Co-Chairman also paid tribute to the architects of the Kyoto Declaration on Aquaculture, which he considered to be one of the most important documents in the development of aquaculture. He credited this to the vision and commitment of those involved, in particular, Dr. T.V.R. Pillay who, he said, was instrumental in Kyoto and, again, provided the spark and encouragement for the Bangkok Conference.

He reiterated the conference concern that the next 20 years will see many challenges in food-producing systems and in balancing the use of natural resources, but also the optimism that it will also benefit from improvements in communication, science and technology. He closed with an appeal for all who are involved in, and benefit from, aquaculture to embrace the Declaration and take it forward with the commitment and courage to do and say what is right and necessary to ensure that aquaculture fulfils its potential. "It will be your courage, your flexibility, your commitment and your integrity and not self-interest or self-promotion that will make the vision of the Bangkok Declaration on Aquaculture a reality," he said. The full text of the TDC Co-Chairman's introduction to the Declaration and Strategy appears as Annex 3.8.

The presentation was followed by a discussion on the substantive issues. The conference agreed to the draft document, with the proviso that additional comments arising from the day's discussion, lodged in writing with the Secretariat by the end of the conference, or submitted to the drafting committee during the one-month period after the conference, would be included in the final document, where appropriate. This procedure was implemented by the TDC, with the assistance of the Conference Secretariat.

The TDC was comprised of 20 persons representing a broad range of expertise and every legitimate stakeholder group in aquaculture: government, non-government, civil society, community-based organisations, farming, business and industry, policy, academe, research and development, and national, regional and international development assistance. The members were from developing and developed countries in the Asia-Pacific, Africa, Latin America, Europe, and North America.

Report of the Conference and Technical Proceedings

In addition to *Aquaculture Development Beyond 2000: the Bangkok Declaration and Strategy*, the two other conference publications are this *Report of the Bangkok Conference on Aquaculture* and the *Technical Proceedings of the Bangkok Conference on Aquaculture*. The detailed recommendations of the thematic sessions are included herein. These were developed by the members of the session panels and other associated experts during the conference, presented in a plenary session, redrafted, and then refined through consultations by correspondence among the panel members and other associates after the conference.

The *Technical Proceedings of the Bangkok Conference on Aquaculture* will include the full texts of the global, regional and thematic reviews, the keynote and plenary lectures, and the contributed technical papers. The latter will be subject to the peer-review process.

1.3.4 Inputs

Three sets of major inputs to the conference were presented: the global synthesis and regional reviews of aquaculture development status and trends; thematic reviews; and keynote papers and plenary lectures. In addition, some 60 abstracts and/or full manuscripts of technical and experience papers were contributed, 40 of which were presented as posters at the Aquaculture and Seafood Exhibition Hall.

Keynote Papers

Two keynote papers were presented at the start of the conference. The first, *From Kyoto 1976 to Bangkok 2000*, by Dr. T.V.R. Pillay, reviewed the progress of aquaculture since the Kyoto Conference, highlighted the recommendations of the conference that were successfully put into practice, and focused on crucial development challenges. Dr. Pillay was lead person in the Kyoto Conference, former co-ordinator of the UNDP/FAO Global Aquaculture Development Co-ordinating Programme based in FAO, and NACA Adviser.

The second keynote paper, *Aquaculture development beyond 2000: global prospects*, by Mr. Jia Jiansan, outlined the prospects and potential for aquaculture development into the new millennium. The constraints and opportunities on a global, as well as regional perspective were described, and a number of strategies were highlighted that could make aquaculture respond more effectively, in a sustained manner, to social development needs, particularly those of providing nutritious food to increasing populations and improving livelihoods. Jia Jiansan is FAO's Chief of the Inland Fisheries and Aquaculture Services (FIRI). The keynote paper was developed in collaboration with Messieurs Ulf Wijkstrom, Rohana Subasinghe and Uwe Barg. The keynote papers will appear in the *Technical Proceedings of the Bangkok Conference on Aquaculture*.

Global and Regional Reviews of Trends in Aquaculture Development

The synthesis of global aquaculture development status, trends and issues; and the regional reviews of the development status, trends and issues (which largely, but not solely, formed the basis of the global synthesis) from eight regions (Asia, the Pacific Island Nations and Oceania, Sub-Saharan Africa, Latin America and the Caribbean, Europe, the former USSR countries (with a supplementary presentation on Ukraine's aquaculture history, development and status), North America, and the Near East), as well as from China, were presented in plenary in Session 1, also on the first day of the conference, following the keynote papers.

The titles of the reviews and the names of the reviewers are listed below (if more than one reviewer, the person whose name is underscored gave the presentation):

- Asian aquaculture: trends, issues and prospects, *Hassanai Kongkeo*
- Current status of aquaculture in the Pacific Islands, *Tim Adams, Johann Bell and Pierre Labrosse*
- Aquaculture in China, *Wang Yianliang*
- Sub-Saharan African aquaculture, *Cecil Machena, John F. Moehl, Jr., A.G. Coche and V.O. Sagua* (abstracted and presented by *Matthias Halwart*)
- Aquaculture status and development trends in Latin America and the Caribbean, *Cesar Alceste-Oliviero and Manuel Martinez-Espinosa*
- Aquaculture status and development trends in Near East countries, *Abdel El Gamal* (abstracted and presented by *Krishen Rana*)
- North American review on trends in aquaculture development, *Paul G. Olin*
- Aquaculture development trends in the former USSR countries, *Laszlo Varadi, Sergey Blokhin, Ferenc Pekar, Istvan Szucs and Imre Csavas*
- Aquaculture development trends in Europe, *Laszlo Varadi, Istvan Szucs, Ferenc Pekar, Sergey Blokhin and Imre Csavas*
- A global perspective of aquaculture in the new millennium, *Sena S. de Silva*

Plenary Lectures

The six plenary lectures, presented on succeeding days, broadly provided the setting for the thematic sessions. These were on the following areas:

- Policy-making and planning for aquaculture, *Ulf Wijkstrom*
- Technologies for sustainable aquaculture development, *Patrick Sorgeloos*
- Regional and inter-regional Cupertino for sustainable aquaculture development, *Lennox Hinds*
- Human resource development for sustainable aquaculture development, *Sena S. de Silva, Michael J. Phillips, Sih Yang Sim* and *Zhou Xiaowei*
- Aquaculture and trade, *Helga Josupeit* and *Audun Lem*
- Livestock production: a model for aquaculture?, *Robert A. Swick* and *Michael C. Cremer*

Thematic Reviews

There were 14 thematic reviews on policy, planning and technological aspects of sustainable aquaculture development. Each thematic review was conducted by a panel of experts headed by a chairperson. The names of the persons presenting the reviews are listed below. The full list of contributors to the review process will appear in the *Technical Proceedings of the Bangkok Conference on Aquaculture*.

- Increasing the contribution of aquaculture for food security and poverty alleviation, *Albert G. J. Tacon*

- Integrating aquaculture into rural development in coastal and inland areas, *Simon Bland*
- Involving stakeholders in policy-making, planning and management, *Sevaly Sen*
- Promoting sustainable aquaculture through economic incentives, *Rolf Willmann*
- Establishing legal institutional and regulatory frameworks for aquaculture development and management, *Annick Van Houtte*
- Building the information base for aquaculture policy-making, planning and management, *Yong-Ja Cho*
- Aquaculture systems and species, *Harald Rosenthal*
- Genetics in aquaculture development, *K. Majumdar* and *R. Dunham*
- Aquaculture health management, *Rohana Subasinghe*
- Nutrition and feeding, *Sadasivam Kaushik* and *M. R. Hasan*
- Culture-based fisheries and enhancement, *K. Lorenzen*
- Systems approach to aquaculture management, *C. E. Boyd and M. J. Phillips*
- Aquaculture products: quality, safety, marketing and trade, *Helga Josupeit and Audun Lem*
- Aquaculture development: financing and institutional support, *Ron Zweig*

The extended summaries of the above inputs, except the global synthesis, which appeared in full, were published in the Book of Synopses that was distributed to the participants before the conference. As mentioned above, the full text of all papers will be published in the *Technical Proceedings of the Bangkok Conference on Aquaculture.*

A list of all the papers presented at the conference, including keynote papers, global synthesis, reviews of regional development status and trends, thematic reviews, plenary lectures, and technical papers appears as Annex 3.9.

2 CONCLUSIONS AND RECOMMENDATIONS OF THE SESSIONS

2.1 Introduction

There were four thematic sessions: policy-making and planning for sustainable aquaculture; technologies for sustainable aquaculture; aquaculture products: quality, safety, marketing and trade; and aquaculture development: financing and institutional support. The sessions on policy-making and planning and technologies for sustainable aquaculture development each consisted of six sub-sessions, for a total of 14 discussion sessions.

This section gives the full summary and conclusions (background and issues) and recommendations based on the conference sessions and deliberations of each discussion session. The primary basis of the reports is the thematic reviews presented at each session, the panel discussions and the highly intensive open fora. The session summaries were prepared by the chairpersons and rapporteurs (who were also panel discussants), in collaboration with the other panellists of each session. First drafts of the session reports were presented at the penultimate plenary session and further discussed. The chairpersons, rapporteurs and panellists then incorporated the results of the penultimate plenary forum into their reports, which were subsequently written up as conclusions (background and issues) and recommendations.

2.2 Thematic Session 1 – Policy-Making and Planning for Sustainable Aquaculture Development

2.2.1 Thematic Session 1.1: Increasing the contribution of aquaculture for food security and poverty alleviation

Chairpersons	:	Peter Edwards and Albert G.J. Tacon
Rapporteur	:	Lena Westlund Lofval
Members	:	Mahfuzuddin Ahmed, Denis Bailly, D. K. Chowdhury M. C. Nandeesha, Philip Townsley, Wilfredo Yap

1. Aquaculture and fish as food: Background and issues

- Access to proper food and nutrition is a fundamental human right.
- Poverty is one of the major causes of food insecurity; poverty eradication is essential to improving access to food.
- Aquaculture contributes to food security and poverty alleviation (livelihoods) in two ways: as a direct source of nutritious and affordable food for the poor, and as a productive activity generating employment and income for the poor.
- Food fish has a nutritional profile superior to all other terrestrial meats, being an excellent source of high quality animal protein and highly digestible energy. It is an extremely rich source of omega-3 polyunsaturated acids, fat soluble vitamins (A, D and E), water soluble vitamins (B complex) and minerals and trace elements (calcium, phosphorus, iron, iodine and selenium).
- Within many developing countries in Asia and Africa (particularly in Low-Income Food-Deficit Countries, LIFDCs), people are much more dependent on fish as a part of their daily diet than are people living within most developed countries. This is especially true for vulnerable groups, such as pregnant/lactating women, infants and pre-school children, who have a higher physiological demand for nutritious food.
- Highly productive and intensive systems, using formulated feed, tend to produce higher value aquaculture products for export or domestic consumption. These products may not be affordable or accessible to poor consumers. Systems producing products affordable to the poor generally use extensive and semi-intensive modes of production with predominance of natural feed. Such low-cost produce may be produced by richer farmers operating large-scale farms supplying the urban poor. In rural areas where distribution systems are often under-developed, production of aquaculture products by small-scale farmers may be an important source of fish for the poor.

Recommendations

From a nutritional point of view, the production of aquaculture products for human consumption should be encouraged and promoted.

Systems for the production of low-value fish affordable for the poor should be promoted.

2. Aquaculture for rural livelihoods: Background and issues

- The constraints to the development of aquaculture for food security and poverty alleviation are economic, social and institutional, rather than purely technical.
- Developing the small-scale rural sector in aquaculture requires initial support, and more support is needed, and for longer periods, for poorer target groups.
- The development of small-scale rural aquaculture in Asia is facilitated by the cultural, social and technological context.

- The results of efforts to develop rural aquaculture in Latin America and Africa have often been well below expectations, and the approaches used have been wrong. Currently, the resources in many of these countries are declining and, as a consequence, institutional support for rural aquaculture development is diminishing.
- Rural aquaculture cannot be considered in isolation from rural development. Aquaculture development should be an integral part of rural development and not be seen in separation from other livelihood development strategies.
- The development of small-scale aquaculture is as dependent on an enabling institutional, economic and political context as is any other activity.

Recommendations

- The extension and development approaches used for rural aquaculture need to be improved. These should include:
  - a holistic, farming systems-based approach integrating aquaculture into rural livelihoods;
  - a participatory, needs-based approach that takes full account of the capacity of the poor, the resources available to them, and the risks they face;
  - farmer-led extension and research; and
  - promotion of sustainable, appropriate technologies commensurate with the resources available.
- Rural aquaculture has to be developed as an entrepreneurial activity that is financially viable, even for small-scale operations. This means that choices regarding the species produced should be based on the best benefits for the producer.
- Improved information on small-scale rural aquaculture, its role in rural livelihoods and its impact on food security and poverty alleviation need to be developed and understood, and monitoring systems established. This will require the development of better indicators.

3. Aquaculture and poverty alleviation: Background and Issues

- Aquaculture is not necessarily an appropriate activity for the poor because it requires secure access to resources. Opportunities for involving the poor in aquaculture can be found by exploiting small, marginal or under-utilised water resources; securing their access to common-pool resources; strengthening their capacity for management through associations or community-based organisations; and involving them in service provision for aquaculture.
- Furthermore, aquaculture may adversely effect the livelihoods of the poor by diverting food resources for use as feed, degrading the environment, affecting access to common-pool resources and disrupting already vulnerable livelihood strategies.

Recommendations

- The involvement of the poor in aquaculture must be based on a careful and realistic assessment of their needs, capacity and access to resources, and the risks they face.
- Aquaculture development should not adversely effect the livelihoods of poor people. All aquaculture developments should specifically address and minimise any potential adverse impacts on the poor.

2.2.2 *Thematic Session 1.2: Integrating aquaculture into rural development in coastal and inland areas*

Chairpersons : Simon Bland and Chua Thia Eng
Rapporteur : Graham Haylor
Members : Martin Bilio, John Corbin, Matthias Halwart, John Hambrey, Marie Antoinette Juinio-Menez, Donald MacIntosh, M. Sakthivel, Jintao Xu

1. Policy coherence: Background and Issues

- There are often many sectors involved in rural development whose objectives are sometimes conflicting and counter-productive; communication among stakeholders and between agencies with separate but overlapping mandates is often limited.

Recommendations

- To encourage essential policy coherence, we suggest a multi-sectoral co-ordinating process, which brings the stakeholders together to harmonise rural development activities and maximise coherence. Two focal points for co-ordination, one at the sectoral policy formulation level and one at the point of service extension, would help validate if policy coherence is being achieved; this would also provide a mechanism to link stakeholders to policy decisions.

2. Aquaculture planning and rural development objectives: Background and Issues

Aquaculture planning, being an emerging activity, is often carried out in relative isolation from other development and resource planning activities.

Recommendations

- Aquaculture planning should be integrated into water resource management planning for inland areas and into coastal management planning in coastal areas, as well as into other economic and food security interventions for rural areas. This approach provides an overall management framework to enable efficient use of limited resources and adds diversity and value to sectoral management interventions.
- Experience does not yield a universal model for integration of aquaculture development into rural development planning and management. However, we recommend an advocacy function to raise awareness and educate policy makers and those who implement rural development plans, of aquaculture's potentially important role. This will include raising awareness of appropriate entry points.

3. Balance of impact: Background and issues

- Some aquaculture activities have caused undesirable environmental, social, economic and cultural impacts which have damaged public perception of the positive benefits of aquaculture in rural development.
- Poor people are often inadequately considered, yet aquaculture has demonstrated potential for poverty alleviation, and when integrated with other economic activities, the potential for synergies.

Recommendations

- There is a strong case for interventions to be planned and strategic.
- Regulatory and mitigatory mechanisms (e.g., taxation, financial incentives, voluntary compliance, etc.) should be in place and related to best management guidelines. Innovative solutions are required to the issues of tenure and user rights in open access and common property resources.

- Aquaculture development responsibilities should be clearly defined within and among the public sector, private sector, civil society and producers.
- Improved communication strategies are needed, particularly through extension delivery systems and information technology.
- Put people first in planning and development, and give special consideration to poor people.
- Aquaculture should be integrated into rural development, as it has the potential for poverty alleviation through direct involvement of rural people in aquaculture production, as well as through employment or involvement in support activities (e.g., fry nursing, feed collection, transport, etc.).
- Poor people are sometimes inadequately considered and served by aquaculture initiatives in rural development; this should be addressed by a strong national policy.
- The mechanism for policy development, implementation and feedback should be participatory and involve an understanding the livelihoods of poor people. It should improve basic knowledge and skills, utilise indigenous knowledge and empower people to make informed actions.

4. Integration for wider benefit sharing: Background and issues

- Aquaculture has been successfully integrated with other economic activities (agriculture, animal husbandry, tourism, water management) with demonstrated benefits and synergies.

Recommendations

- These successes need to be documented and more widely shared and promoted, in order to provide better options for diversified and more stable livelihoods, and to optimise use of limited resources (e.g., multiple use of irrigation water, optimal energy flows, human resources).
- Strong efforts are needed to document, widely disseminate and utilise successful farmer-proven examples (e.g., analysed case studies with identified benefit).

2.2.3 *Thematic Session 1.3: Involving stakeholders in aquaculture policy-making, planning and management*

Chairpersons : Edwin Rhodes and Sevaly Sen
Rapporteurs : Helen Dixon and Richard McLoughlin
Members : Imtiaz Ahmed, Nazmul Alam, Martin Bilio, Jason Clay,
Courtney Hough, A. M. Jayasekera, Bjorn Myrseth,
Joaquin Orrantia, Mark Prein, Phil Townsley

Background and Issues

- Stakeholder involvement in policy-making, planning and management is both context and country specific. As such, recommendations can only be presented as a framework for the various processes to operate within.
- There was a general feeling that the right process, and management of that process, is critical to achieving a best result for aquaculture stakeholders. However, there was acknowledgement that the possibilities of stakeholder involvement are intricately linked to existing political structures. This means that there is a need for pragmatism and realism about the use of stakeholder involvement in particular contexts.
- The need for a high level of certainty about the rights of stakeholders when involving them in policy development and planning was also highlighted, so that all participants understood exactly what the process would be and what was expected of them while participating.
- Another area of concern was that some vulnerable groups may be threatened by the process itself and choose not to participate. If these groups are likely to be impacted by aquaculture development, their specific concerns must be identified and incorporated.
- Stakeholder identification emerged as a problem for stakeholder involvement. General criteria cannot be developed for identifying stakeholders, as stakeholder identification is very context specific. However the session concluded that the identification process must be iterative and that potential stakeholders must have access to consistent (and not conflicting) information to enable them to determine whether or not they should participate.
- Furthermore, for stakeholder participation to be cost effective, the number and type, as well as the level of stakeholder involvement needs to match the scale of issue under discussion. For consideration of national economic development policies involving aquaculture, community and industry-level involvement would be desirable, along with national or state governments. Conversely, individual farm proposals are best considered at the level of communities and local government, within the context of applicable social, environmental and economic policies.

Recommendations

1. Create an enabling environment for stakeholder participation

- Laws and regulations should enable participation.
- Process objectives should be realistic, and strive for a balance with what is established.
- There must be a commitment to stakeholder involvement from government.
- Where lacking, policies have to be developed to validate the participatory process, and encourage and allow the participation of stakeholders.
- To encourage stakeholder participation, issues need to be kept simple and appropriate.
- In some situations, economic incentives may have to be provided for stakeholder participation.

2. Decision-making processes

- Transparency and legitimacy of decision-making processes need to be improved, so that the process is seen as fair and balanced.
- Information gathering, interpretation and dissemination must be transparent, relevant and clear. In particular, such information should enable poorer stakeholders to make decisions.
- Rules of decision-making need to be established right at the beginning, together with the objectives of the process (e.g., agreement on what is to be decided, how it will be decided and by whom).
- For greater effectiveness, involvement should occur at inception.
- Cost of the process must be determined and a budget allocated.

3. Roles and responsibilities of stakeholders

- Strengthen stakeholder capacity through education and training to enable stakeholders to deal with technical information, present their own case (or local knowledge), and participate on an equal footing.
- Encourage the establishment of organisations to represent the interests of key stakeholder groups.
- The structure of stakeholder organisations should be appropriate to the local social, political and institutional context.
- Encourage conflict resolution mechanisms, which may be outside of government involvement.
- Encourage the establishment of self-regulatory processes.

2.2.4 *Thematic Session 1.4: Promoting sustainable aquaculture through economic incentives*

Chairperson : Rolf Willmann
Rapporteur : Helen Dixon
Members : Denis Bailly, Stefan Bergleiter, Jason Clay,
Anantha Duraiappah, John Hambrey, Adis Israngkura
Lena Westlund Lofval

Background and issues

- To date, the most commonly used instruments to influence aquaculture activity have been command and control. Regulations are within the logic of public administration; they create a sense of equal treatment and they can be politically rewarding. However, they lack flexibility or adaptability, they are often inefficient, and they may be a disincentive to technical and social innovation.
- Incentives, on the other hand, are used to influence and co-ordinate economic activity through motivation. Incentives change the built-in social and economic incentive structure which individuals face, so that the best private choice can be encouraged to coincide with the best social choice. Incentives may be used to promote the social or collective goals of poverty alleviation, food security, equity, efficiency in resource use, risk reduction and conflict avoidance or resolution.
- Incentives take a variety of forms. *Improving and crafting institutions* can be done through strengthening rights, promoting participatory decision-making, and interest group formation and empowerment. *Economic instruments* include taxes, subsidies, charges and fees. *Tradable rights* (e.g., those related to water use) allow a created market to determine the value of a previously untraded good or service. *Product labelling* (e.g., organic, fair trade or eco-labelling) offers an incentive to producers to meet the social and environmental concerns of consumers. *Information and persuasion* can help create desirable behavioural norms and values. This can be done through voluntary codes of conduct/practices, and awareness creation and education.
- Incentives have significant strengths. They are flexible and responsive and can be closely attuned to specific objectives. They allow more room for and, in some cases, stimulate technical and social innovation. Greater responsibility is given to individuals and groups to achieve collective objectives.

Recommendations

- Incentives, specifically economic incentives, deserve to be given more attention in the planning and management of aquaculture development. However, they are not a panacea; in many circumstances command and control will remain an important tool.
- When introducing incentives attention should be paid to the following:
    - the feasibility and impact of different forms of incentives will vary greatly according to objectives and circumstances.
    - some incentives may have a differential impact on large and small-scale producers, on extensive and intensive producers, or on urban vs. rural producers.
    - their introduction may change the structure of the industry. Incentives applied to aquaculture may have effects on other sectors, and vice-versa, through social, economic and ecological linkages.
    - the effectiveness of economic and other incentives will depend upon the institutional framework.
- Research is needed to identify problems, set objectives, and build capacity to ensure effective use of incentives.

- The development of suitable incentives should be based on a process of consultation, negotiation and participation. Ideally, they should be developed as part of a broader planning process.
- Monitoring the impact of incentives, assessing the need for enforcement, and adjusting as necessary are vital, if incentives are to meet their objectives.
- Stakeholder representation and ORGANISATION should be encouraged or supported to facilitate the development and implementation of appropriate incentives.
- Information, specifically in relation to practices or technology that yield both environmental and financial benefits to producers, can be a relatively cheap and effective incentive. Appropriate training at the technical and managerial levels should accompany incentives.
- Defining and allocating access and user rights may be used to promote both equity and efficiency objectives. Creating a market for these rights can reinforce resource use efficiency, but potential social impacts should be carefully assessed.
- Subsidised credit should be conditional on meeting sustainability objectives. It should always be used with a range of other supporting interventions, such as training and capacity building. Subsidised credit can be very effective at promoting aquaculture development, especially among the poor. Credit should be used in association with effective investment screening and monitoring.
- Taxes should be linked to specific objectives. Revenues generated should be returned to help the sector meet social and environmental goals.
- Product labelling and certification must address fundamental problems and not those of specific interest groups. Producer organisations can facilitate access to these schemes by small-scale farmers.

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2.2.5 *Thematic Session 1.5: Establishing legal institutional and regulatory frameworks for aquaculture development and management*

Chairpersons	:	Annick Van Houtte and Richard McLoughin
Rapporteurs	:	Uwe Barg, Margaret Eleftheriou, Sunil Siriwardena
Members	:	David Barnhizer, Courtney Hough, Richard McLoughin Alessandro Piccioli, Edwin Rhodes, Sevaly Sen Paula Shoulder

Summary of Discussions

A review of the recent trends in legislation governing aquaculture was presented and followed by a summary of the findings and conclusions of the discussions within the panel. The ensuing discussion focused on a number of key areas:

- It was noted that confusion due to overlaps and duplication of laws and regulatory requirements governing aquaculture is a significant problem in many countries. There are often different types of rules and regulations designed for purposes other than aquaculture, and numerous agencies mandated responsible for different aspects of aquaculture production and produce. It was noted that mandates and competencies of agencies may need to be modified or enhanced to improve co-ordination and consultation, especially those concerning the complex issues of resource use and environmental management. Options were discussed regarding the establishment of a single authority with responsibilities and mandate for all aspects of aquaculture, or alternative institutional arrangements of co-ordination and management, such as inter-agency committees.
- It was recognised that there may be advantages and disadvantages of developing and enacting a specific aquaculture law. Since aquaculture shares many characteristics with agriculture and industrial activities, as well as fisheries, it is important that due recognition is given to the activity of aquaculture practice. A thorough review of existing legislation is usually appropriate. Aquaculture-specific legislation should be drafted which is practical and flexible, so that it can be adjusted and modified to changing circumstances and expectations. Specific reference was made to initial stages of aquaculture developments, especially to initiatives involving small-scale and household-level aquaculture.
- Conflicts between resource users can be addressed through partnership agreements defining rights, privileges and duties of all concerned. Additional arrangements may include zoning of designated areas, as well as the promotion of codes of practice, best management practices, and other self-regulatory mechanisms. It was emphasised that producers and other stakeholders and their needs and interests need to be recognised. Their involvement in decision-making, as well as opportunities for Cupertino with government agencies, should be facilitated through legislation. Community education towards self-regulation was proposed.
- A recent example from Japan discussed self-regulatory and voluntary arrangements being promoted in Cupertino with producers to better manage seabed environments, as well as to prevent the spread of diseases caused by the introduction of exotic pathogens.
- The relevance of international trade and its effects on aquaculture-related legislation was raised. Specific reference was made to World Trade Organisation Sanitary and Phytosanitary (WTO SPS) requirements for countries to harmonise regulations and laws with regard to the *Codex Alimentarius* and OIE *International Aquatic Animal Health Code*. In addition, it was noted that two codes were being drafted/revised (1) the draft code of hygienic practice in aquaculture, and (2) the code on molluscan shellfish.
- A suggestion was made to enhance legislation related to investment and financing of aquaculture development. Positive experiences were mentioned where opportunities of receiving grants and credits were linked to level of education and certification of skills in aquaculture farm management.

- It was recognised that laws and regulations are not the only means available for promoting sustainable aquaculture development. The existence of a clearly defined and well-constructed legal framework will not necessarily result in improved performance, which may be related to enforcement and surveillance, as well as to other governance problems. The need for skilled manpower and for training at different levels was emphasised. Guidelines are needed for environmental impact assessment, for mitigation of environmental problems, and for good planning of aquaculture development. Opportunities for economic and other non-regulatory incentives for more sustainable aquaculture management were recognised and referred to discussions in other sessions of the conference.

Background

- Legal, institutional and regulatory frameworks have an important role to play in enabling and supporting the sustainable development and management of aquaculture. The FAO Code of Conduct for Responsible Fisheries, Article 9.1, stresses the need for all States to "establish, maintain and develop an appropriate legal and administrative framework which facilitates the development of responsible aquaculture." Numerous countries have enacted specific rules relating to aquaculture, either under an aquaculture-specific legislative text, under a basic fisheries law or under laws for the use of natural resources.
- A major threshold issue in relation to the establishment of a legal framework for aquaculture concerns the identification of the activity and its various participants. The legislation of many countries already incorporates environmental and social responsibilities in the management of natural resources on which aquaculture development depends. In some cases, aquaculture is regulated through statutes originally developed for other purposes, and this has resulted in unintended consequences for the aquaculture sector. The formulation of legislation to protect and responsibly manage aquaculture activities and its interaction with the environment, and which does not create unreasonable barriers for the development and sustainability of aquaculture, still needs to be addressed.
- Governments are still uncovering potential institutional and legal issues deriving from the existence of the complex network of institutions and mandates involved in the regulation of aquaculture. The overall effectiveness of a legal system for the management of aquaculture depends largely on the performance of state aquaculture administration.
- Institutions responsible for aquaculture management range from a single lead institution or agency to a plurality of institutions, departments, services and units dealing with various functions and responsibilities related to aquaculture. Co-ordination between these institutions has thus become a major task. In addition, the current lack of participatory processes (in which a variety of legitimate stakeholders have a realistic voice in discussions) does not allow for the degree of transparency and accountability necessary in the governance of aquaculture activities.

Issues

The following key issues provided the focus for the development of discussions to arrive at recommendations for effective legal institutional and regulatory frameworks to enable and support sustainable aquaculture:

1. On regulatory instruments

- Recognition of the activity (the practice, the facility, the product) and the various players involved.
- Integration of environmental and social values into the planning and decision-making process for the allocation of land, water and other natural resources for aquaculture purposes.
- (Re)-definition of the regulatory, managerial and other roles of the government (central, local, horizontally and vertically).

- Opening the process of aquaculture management to non-governmental components of civil society, including the private sector, the community, traditional users, aquaculturists, etc. Possible means include:
  - partnership/co-operation agreements between, for example, other users and aquaculturists for a designated land/water; and between other users, aquaculturists and the government.
  - delegation of powers.
- Use of economic, administrative and penal enforcement and implementation mechanisms to encourage compliance with the rules of the game, including codes of conduct and best management practices.
- Use of other regulatory tools, such as codes of practice and codes of conduct.
- Establishing incentives for sustainable aquaculture.

2. On the institutional framework

- Need for a lead agency with a strong co-ordinating role dealing with operation and management aspects.
- Need for a co-ordinated approach towards efficient enforcement of all laws and regulations applicable to aquaculture.
- Role of incentives and support directed to the development of environmentally friendly practices and improved techniques towards the implementation of environmental laws and regulations.
- Consumer-related issues.
- Need for regular assessment and monitoring of the efficiency of the management of the aquaculture sector; possible criteria for assessment; efficient resource use, economic viability and public benefit.

Recommendations

A primary goal of a legal framework by means of which aquaculture activities are governed should be to enable and support the sustainable development and management of aquaculture.

1. Effective aquaculture legislation or future reform of existing legislation should:

- Recognise and identify the activity (the practice, the facility, the product) and the various stakeholders involved.
- Integrate environmental and social values into the planning and decision-making processes for the allocation of land, water and other natural resources for aquaculture purposes.
- Recognise the legitimacy of regulatory instruments, such as the FAO Code of Conduct for Responsible Fisheries and similar codes of practice and codes of conduct which promote responsible aquaculture practices.
- Include effective monitoring and implementation mechanisms and enforcement tools (economic, administrative and penal) to ensure compliance with the regulatory instruments, including codes of conduct and best management practices.
- Develop and implement performance criteria and indicators that will enable governments and stakeholders to assess whether the objectives pertaining to responsible aquaculture are being achieved.
- Establish clear user rights and responsibilities for the specific purposes of aquaculture. Such user rights and responsibilities should be legally recognised, and take account of the effects, potential or real, of other human activities that interact with aquaculture.
- Be formulated as an adaptive process based on a regular feedback from various stakeholders (governmental and non-governmental).

- Review, identify and, as appropriate, reconcile those provisions in laws and regulations that do not match the needs of a responsible aquaculture sector and hence, do not enable and support the sustainable development and management of aquaculture.

2. In order to promote, support and regulate responsible aquaculture, an institutional framework for aquaculture should:

- Be directed towards the objectives of an aquaculture policy and hence, aquaculture legislation, in order to ensure its successful implementation.
- Identify the responsibilities of the agency or agencies in relation to the development, operation and management of aquaculture. Where appropriate and where several agencies are involved, it should foster and promote the creation of networks to facilitate the implementation of responsible aquaculture practices.
- Open the processes of the management of aquaculture to non-governmental participants, including the private sector, the community, traditional users and aquaculturists, through, for example: (a) partnership agreements between other users and aquaculturists for a designated land/water area; and between other users, aquaculturists and the government; and (b) delegation of powers.
- Foster an approach between government and non-governmental participants for co-ordinated enforcement of all laws and regulations applicable to aquaculture.
- Create incentives (financial, educational and others) for responsible aquaculture geared towards improving existing farming systems, developing and implementing best management practices, supporting implementation of effective environmental requirements affecting aquaculture, and supporting the maintenance and restoration of the environment.
- Monitor and regularly assess the aquaculture sector management against criteria provided via regulatory instruments. These criteria may entail efficient resource use, economic viability and public benefit.

2.2.6 Thematic Session 1.6: Building the information base for aquaculture policy-making, planning and management

Chairperson : Jorge Calderon
Rapporteurs : Pingsun Leung and Krishen Rana
Members : Jose Aguilar y Manzares
Pedro Bueno, Rainer Froese, Fatima Ferdouse, Ian MacRae
Ataur Rahman, Yong Ja Cho

Background and Issues

- The purpose of information base is to support sustainable aquaculture i.e., socially equitable, economically viable and environmentally sound aquaculture. Planners and decision-makers need to have access to, and utilise, appropriate indicators of performance for the sector and indicators of future potential. These should be used to define the scope of core data to be collected.
- Discussions stressed that high level political will is essential for the implementation of actions necessary to improve availability, accessibility and utilisation of data and information for policy-making, planning and management of the aquaculture sector and related environment. It was highlighted that most of the recommendations made in previous meetings have not been implemented, and that there is a need to examine the underlying reasons for this. It should be noted that the value of information and the importance of its accessibility to all stakeholders are highlighted in other thematic sessions of this conference.

Recommendations

The recommendations of the session are summarised under each of the six identified major issues.

1. Poor understanding of the purpose of data and information collection

- Improve awareness that data and information are collected to meet the information needs of the target users i.e., data and information collection is not an end in itself; it must be used to support and facilitate policy-making and management decisions.
- Strengthen national capacity to determine data needs of target users and identify types and scope of data to be collected and compiled.
- Improve accessibility and availability of usable information, taking advantage of rapidly advancing information and communication technologies.
- Promote awareness among data and information providers regarding the purpose of data collection through improved feedback and sharing of benefits attained from use of information derived from the data provided.
- Assess cost-benefits of data collection. Data and information collection, compilation and analysis are costly to both the agencies that collect data and to data providers. The costs associated with data and information collection and analysis should be matched by benefits to all stakeholders resulting from informed decisions and subsequent policy and management interventions.
- Initiate studies to identify practical key indicators of performance, as well as indicators of future potential, for the management of aquaculture and the associated aquatic environment.

2. Under-utilisation of data and information

It was recognised that a considerable amount of data and information are collected and compiled, but are not readily available and/or not effectively utilised. The recommendations are to:

- Promote co-ordination and integration of the activities relating to collection, compilation, analysis, dissemination and utilisation of information as an integral part of the sector management and planning at all levels.

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- Improve the understanding of the purpose of the information base.
- Initiate compilation and exchange of aquaculture policy reviews and policy options, including highlights on lessons learned and successful policy and management interventions.
- Facilitate development of analytical and forecasting tools and their adoption and application.
- Improve accessibility and availability through production of a directory of the existing information resources.

3. Ineffective communication and presentation

- Improve the understanding of data and information flows from provider to user and the data format requirements and communication characteristics of the target users.
- Improve the availability and accessibility of data and information through targeted analysis, synthesis, packaging and delivery.

4. Poor relevance, reliability and timeliness of, and gaps in, data and information

- Facilitate assessment of the national aquaculture data and information systems, particularly their ability to support policy-making, planning and management.
- Strengthen national aquaculture data and statistics systems, including improving linkages with relevant agencies, institutions and related sectors.
- Upgrade the capacity of institutions and the skills of personnel involved in data collection and compilation at the local and field levels.
- Improve the quality of the data and information collected and ensure that it is sufficient to facilitate forecasting of impacts and implications of policy and management interventions.

5. Lack of internationally comparable and compatible methodologies for data and information handling

- Give high priority to the establishment of internationally agreed-upon norms, definitions and classifications.
- Encourage and promote national efforts to harmonise and standardise the methodologies used for aquaculture data and information handling.

6. Limited capacity of national programs

- Promote awareness that effective and efficient utilisation of information as a means to complement, as well as support, all other efforts to achieve the goal of sustainable aquaculture.
- Give greater emphasis to national capacity building, particularly human resource development, through training workshops on aquaculture policy-making, planning and management; data and information collection at local and field levels; analysis and synthesis of data and information; and effective presentation and communication.

2.3 Thematic Session 2: Technologies for sustainable aquaculture development

2.3.1 Thematic Session 2.1: Aquaculture systems and species

Chairpersons : Harald Rosenthal and Laszlo Varadi
Rapporteurs : Simon Funge-Smith, C. Kwei Lin, Jacques Moreau, Peter Montague
Members : Yoram Avinimelech, D.K. Chowdhury, Rafael De Guerrero III, Eva Roth, Piamsak Menasveta, Siri Tookwinas, Ole Torrissen, Marc Verdegem

Background

General statements

- Aquaculture technology improvements will not achieve sustainability unless they are met by adequate policies, socio-economic criteria and environmentally sound regulatory frameworks (e.g., monitoring, enforcement, less corruption).
- In the 21st Century, water will be at a premium, water shortages will become critical after 2015, and business-as-usual scenarios will no longer be possible. Competition for this resource will increase, and drinking water shortages will affect large populations by 2025.
- Aquaculture incorporates essential elements of care of aquatic stocks, requires confinement or site allocation, isolates to varying degrees farmed stock from the external environment, allows various levels of internal control of systems, and requires allocation of some form of ownership.
- Aquaculture systems must be considered in relation to natural resource systems (sustainability criteria, including socio-economics; the wider interaction between aquaculture and other processes and activities, which works both ways - the impact of aquaculture on other water resource users, and impact of others on aquaculture).

Types of systems

- Systems range from very extensive, through semi-intensive and highly intensive to hyper-intensive. In using this terminology we must define what we mean for each individual project, as there are no clear distinctions; levels of intensification represent a continuum.
- Aquaculture systems and species are very diverse; for example, they include:
- Water-based systems (cages and pens, inshore/offshore).
- Land-based systems (conventional ponds, flow-through systems, ponds, tanks and raceways).
- Recycling systems (high-tech., PAS-System).
- Integrated (e.g., dual ponds).
- Various organisms are grown in different ways:
  - Fish (ponds, polishing ponds, integrated pond systems).
  - Seaweed (floating/suspended culture, onshore pond/tank culture).
  - Molluscs (bottom, pole, rack, raft, long-line systems).
  - Crustaceans (pond, tank, raceway).
  - Phases of culture include broodstock holding, hatchery, grow-out systems, and quarantine.

Infrastructure and support technologies

- These supporting activities include seeding, handling, feeding, controlling, monitoring, sorting, treating, harvesting, processing and prophylactic measures.

Driving forces for success of aquaculture

- The factors which drive aquaculture cover a spectrum from the needs of people (the provision of local employment, food security and the alleviation of poverty) to the needs of industries (with particular emphasis on profits, productivity and consistent-quality products). Consequently, the technologies for sustainable aquaculture development should provide a varied and adaptable tool kit, from which people can select and design the system which most effectively meets their needs and best fits the opportunities and constraints of the local environment.
- The delivery of such techniques requires efficient communication networks, reliable data on the merits and drawbacks of the various approaches, and help in the decision-making process through which people design their production systems.

Future developments in systems and systems-support technology for conventional pond systems

- Shortage of water will be the limiting factor. Low input and extensive pond aquaculture is an inefficient user. For example, a 1 ha pond can lose 30,000 mt of water per annum through seepage and evaporation, and perhaps produce only 1 mt of fish. Ponds must become more "intensive" with respect to water use. This means new technologies, and training in their use for millions of farmers.
- Flow-through systems can become more efficient through the re-use of heat energy, balancing the cost of water.
- Crucial positive trends are the integration of pond systems with other agriculture and water-using processes, reuse of water, and recirculation. A recirculation system can achieve 150 L water/kg of fish, or 40 L/kg with a de-nitrification unit.

Integrated systems

- Many "outputs," often called "wastes" or "by-products" of subsystems, become basic inputs for other subsystems, rather than just additive components of the overall farm economy.
- The dual pond system in Israel links irrigation water storage with aquaculture ponds, with seasonal transfers according to respective needs of irrigation and culture.
- Cages placed within reservoirs and ponds provide integrative processes on a small scale.
- Use of waste streams (e.g., piggery, industrial) for aquaculture may create ethical issues (moral and public health).
- There are alternative sources of water readily available for aquaculture arising from, for example, floodwater control in Bangladesh, or use of saline ground or surface water not suitable for irrigation or municipal consumption.

Recirculation

- The PAS system for American catfish combines an extensive set of channels within the pond, for water treatment, with a highly intensive growth enclosure. It is characterised by very slow circulation with low energy requirement, and good control of pond processes.
- Recirculation is not necessarily highly intensive; shrimp farmers in Thailand are successfully using closed-pond systems.
- The uses of recirculation vary widely: broodstock management, hatchery rearing, grow-out, quarantine holding.
- There are many possible solutions, adaptable to specific local situations.
- Hyper-intensive recirculation systems have many advantages. These include minimum water demand, limited space demand, reduced water discharge, controlled conditions to optimise

productivity, tight control of feeding to maximise feed conversion efficiency, being fairly site-independent, exclusion of predators and climatic events, and little use of chemicals.

- However, recirculation systems often involve high capital costs, are more complex, and failures are serious. They place greater demands on feed design and health management, and demand professionalism in their use. A well-designed system must be readily managed and competitive in terms of cost-efficiency. This has been successfully achieved in Vietnam and India, and in active suspension ponds, as demonstrated for tilapia in Israel and the USA, and for shrimp culture in Belize, for example.

Technology issues in recirculation approaches

- Limited knowledge about component interactions (biofilters, mechanical filters, energy flows).
- Interaction of pathogens and benign microbes in biofilters is very poorly understood.
- Biofilms, biomats etc need more study.
- Scale-up problems are common; thorough testing is still necessary.
- Modified processes may be required when using new feeds.
- For feeds for recycling systems, there is a need to weigh conversion efficiency versus water treatment efficiency. Feeds can be designed to facilitate the separation of faeces from the water.
- There is a need for predictive modelling to assess multifactor interactions.
- Recirculation techniques can be highly species-specific. Perhaps difficult species can be selected to perform better in recirculation systems. In general, domesticated strains seem to perform best.
- Recirculation systems would be preferred for culture of exotic species and GMOs.
- Intensification can cause stress by disrupting fish social structures – but this varies with species – some do better at high stocking densities, and we need to know more about such behavioural characteristics. Fish may require pre-adaptation to the recirculation environment. Welfare concerns, as well as the desire for better productivity will compel us to design systems to suit the needs of the cultured animal.
- Water is not always the limiting factor – in some cases it may be, for example, reliable energy sources.
- Hyper-intensive recirculation is particularly suited to Europe where there are major environmental pressures and high-priced species.

New approaches

- It was suggested that the main future for aquaculture expansion is in the sea, particularly offshore. The rate of increase in global aquaculture production is slowing. If this is due to production limitations, it suggests we are not using current technologies well, or alternatively, those future increments will be more expensive to achieve. We therefore need fundamental innovations in aquaculture technology.
- However, it was pointed out that the slowing of growth rates was a feature of the major current producers. We should also take account of the huge longer-term potential in South America and Africa, for which suitable technologies might already be available. The immediate need there is to address the socio-economic barriers to development.
- It would also be useful to determine the potential performance of the available species, to help us optimise culture conditions.

Fish cage systems

In Southeast Asia, cage farming of fish is advancing rapidly in a wide range of species. The main limitations are the high cost of feeds and shortage of seed. Little is known of environmental impacts. Each country has its own species, markets and issues.

Inshore-nearshore cage farms

- Environmental impact minimisation, or even positive impacts, can be achieved, as in co-culture, such as combination of cages with seaweed and shellfish culture, and combining cages and artificial reefs (leading to stock enhancement). Technical issues also include:
  - making better nets, (stronger, less prone to attack by predators; and coping with fouling, while reducing the use of antifouling paints).
  - new designs; in particular deeper, larger and submersible cages.
  - increasing scale requires new levels of risk management.
  - equipment for sorting, handling, counting and biomass estimates.
- There are a number of needs related to cage-culture systems and the environment:
  - better knowledge about mortality and the real number of fish in cages, better feeding regimes, with less waste of feed.
  - thorough study of material and energy flows through cage systems.
  - modelling of the environmental impacts (not only benthic deposition, but also nutrient release and dispersal).
  - better knowledge about recovery processes, so as to estimate fallowing time.
  - site rotation: better equipment for simpler mooring.
  - models are lacking that relate to remote zones and interactions between nearby farms.

Offshore cage farming - its technology needs and future

- Open sea farming provides better exchange and dispersion of wastes, can be designed to be technically safe, but needs better surveillance techniques and remote control of feeding. Production costs are still too high and many systems are prototypes. Furthermore, performance of fish may be different offshore than inshore – not enough is known.

- Infrastructure needs are likely to be different from nearshore cage systems.

- Systems may be offshore for a long time without being brought inshore for service - net repair and maintenance will be special issues.

- Different support systems (platforms) may be needed offshore e.g., space for sorting, harvesting, handling, checking and treating.

Infrastructure and support technology

- These issues relate mainly to environmental assessment and planning:
  - Computerisation of aquaculture.
  - Incorporating GIS in system management.
  - Better methodologies for impact assessment e.g., carrying and holding capacity models.
  - Decision-support systems for planning.
  - Better farm management software.
  - Better online monitoring equipment and reliable calibration and self-diagnosis (e.g., for biomass, environmental parameters).
  - Mass application of vaccines and parasite treatments.

Standards for materials

- Other food sectors have strict regulations on materials; these are largely lacking for aquaculture.

- Plastics contain low molecular weight components which may be a source of contamination. These include plasticizers, stabilisers, lubricants, colouring material, UV absorbers, antistatics and flame retardants. Here we may need standards for materials in recycling systems because those going into solution may contaminate the system and the product.

Potential species for aquaculture

- There is a view that we may be trying to culture too many species. However, some important needs were identified – but choices need to be made with great care, taking into account market demand, availability of seed and culture technologies, and the potential environmental constraints. Issues to be considered include:
  - developing indigenous species rather than exotics.
  - filling market niches in particular areas (for example cod, haddock and halibut in cold waters).
  - diversifying is still a priority for Mediterranean aquaculture, where several faster-growing species can occupy the same infrastructure, and their life cycles have been closed.
  - similar comments apply to tropical and subtropical areas, with better prawn species, native fishes, freshwater mussels, shrimps and snails being mentioned.
  - air-breathing fish could fill specific situations of low technology and poor water quality.
  - the priority to close life cycles of species currently being grown out in aquaculture.
  - requirements for more microalgal species for hatchery feeds and production of fine chemicals.

New products

- The economic efficiency of aquaculture can be greatly improved by the discovery of new products, not only for consumption but also for other uses, resulting in fuller use of currently cultured species.

- An example of using fish as bio-reactors or as tools in developing pharmaceuticals was the possible use of salmon in finding a cure for osteoporosis.

Recommendations

- The factors which drive aquaculture cover a spectrum from the needs of people (the provision of local employment, food security and the alleviation of poverty) to the needs of industries (with particular emphasis on profits, productivity and consistent-quality products). Consequently, the technologies for sustainable aquaculture development should provide a varied and adaptable tool kit from which people can select and design the system which most effectively meets their needs and best fits the opportunities and constraints of the local environment.

- To deliver such techniques, efficient communication networks, reliable data on the merits and drawbacks of the various approaches, and help in the decision-making process through which people design their production systems are needed.

- Access to suitable water (coastal, estuarine and particularly fresh water) will be increasingly limited and will be the source of widespread competition. Therefore, we must adopt or develop approaches which:
  - use water more efficiently.
  - promote further integration of aquatic production with agriculture (e.g., crops and livestock), particularly in areas where such approaches are not common.
  - link with, share with or complement other water resource users.
  - use water that is less suitable for competing purposes.

- High-technology systems are often proposed to achieve the more efficient use of water (e.g., recirculation), or to avoid competition for water (e.g. offshore/oceanic farming). Because of the relatively high risk of failure of such systems, we recommend:

  - pilot-scale and full-scale testing, in real settings, for newer culture systems before their adoption by users.
  - standard criteria for materials, procedures and safety margins applied in newer culture systems.
  - codes of practice for specific culture systems as used in specific applications.
- Current recirculation systems are expensive and limited in their species application. The functional interactions of their components are not well understood, and this makes it difficult to optimise systems for specific applications (e.g., quarantine, hatchery, grow-out). There is an increasing need for environmental and system control as a result of intensification. We therefore recommend:
  - the further development of cost-effective recirculation systems for other species.
  - the further development of recirculation techniques for greenwater or turbid water, as well as clearwater systems.
  - research and development on reliable monitoring and management tools that go beyond current limited water quality criteria (e.g., biomass, mortality, growth, behaviour, critical events).
- The composition of discharged water is an important factor in environmental sustainability. We recommend that research continues strongly in the areas of:
  - biological treatment of waste waters, leading to improved design, reliability and cost-effectiveness of such systems, and methods for the disposal of sludge.
  - the development of feeds that minimise the wastage and excretion of nutrients, and facilitate more efficient waste treatment (e.g., faeces separation).
  - use of effluents, including sediments, in other agricultural processes.
- Both the need for efficient use of resources (especially water) and pressures exerted by the community will require that farming systems are designed to meet the needs of the farmed animal. We therefore recommend more research on:
  - the behavioural responses of cultured animals to the culture environment, leading to system optimisation, and in particular, to achieve species compatibility in polyculture systems.
  - the minimisation of stress and other adverse physiological responses to the culture environment and the harvesting process.
  - domestication and selection of animals for improved performance in culture.
- The ability of aquaculturists to meet their diverse needs, in the various environments used, depends on the diversity and adaptability of their system options. One critical option is the cultured species. We, therefore, recommend that research on new species continues in a judicious and selective fashion, particularly in the following areas:
  - development of suitable indigenous species, rather than exotics.
  - use of additional species in geographical regions where major market niches are not yet satisfied (for example, cold water regions and the Mediterranean).
  - closure of life cycles of species already being grown out on a substantial scale.
  - use of air-breathing fish species suitable for culture in systems with unsophisticated technology and poor water quality.
  - use of a wider range of species, including molluscs and crustaceans, for freshwater culture.
- Aquaculture can be made more economically efficient through the development of additional products from the species grown. We recommend more research and development of fine chemical and pharmaceutical products from cultured organisms, including fish and invertebrates, as well as algae and micro-organisms.
- We recommend that sufficient exploratory research be done to achieve a quantum leap in aquaculture productivity, whether by use of novel systems and new species, development of new products, application of genetics and biotechnology or otherwise.
- Aquaculture of all types requires high levels of skill and professionalism, whether it is highly integrated with other users or highly intensive and industrial, and generally, because of its complex interactions with the local environment. We therefore recommend:

- that all relevant agencies strongly encourage programs for the training of aquaculture producers and service providers.
- that the quality of training be assured through industry-based competency standards, the accreditation of courses and frequent re-training of the training providers themselves.
- that there be effective dissemination of information to others who influence the progress of aquaculture, such as policy makers, public servants, investors, engineers, journalists and the general public.

2.3.2 Thematic Session 2.2: Genetics in aquaculture development

Chairpersons	:	Rex Dunham and Ksitish Majumdar
Rapporteurs	:	Devin Bartley
Members	:	Trygve Gjedrem, M.V. Gupta, E. Hallerman, G. Hulata, Zanjiang Liu, Graham Mair

Background

The field of genetics has an important role to play in increasing productivity and sustainability in aquaculture through higher survival, increased turnover rate, better use of resources, reduced production costs, and environmental protection.

However, the application of genetics in aquaculture is at an earlier stage of development than in other food-producing sectors, such as livestock and crop production, where tremendous gains have already been achieved. The increased use of genetics in aquaculture will require resources, but the benefits, in both the short- and long-term, justify this effort.

Recommendations

1. Genetic improvement of aquaculture species

- The genetic improvement of aquaculture species should be given higher priority, with both short- and long-term goals and with appropriate funding.
- Better domestication protocols and broodstock management are needed in many commercial hatcheries.
- Efficient breeding plans need to be developed that may include multiple trait selection, combinations of genetic techniques, and appropriate genetic controls.
- Increased training and capacity are needed to implement genetic improvement programs.
- User networks and information/communication systems should be promoted in order to share expertise and allow easy access to information.

2. Design and promotion of strategies for equitable dissemination of genetic techniques and genetically improved aquatic organisms

- Intellectual property rights need to be addressed and balanced against public information and unrestricted access to information and genetic resources.
- There is a need for greater control on trans-boundary movement of germplasm, which must balance conflicting mandates of international conventions. Networks such as INGA and other appropriate agencies can promote responsible trans-boundary movement of germplasm.
- Efforts should be made to design and promote equitable dissemination strategies that ensure that genetic enhancements have positive impacts on aquaculture, food security and enhance livelihoods.
- Impact assessment of genetically improved organisms and their dissemination should be carried out and should include environmental, social and economic aspects.

3. Application of genetic technologies to the conservation of aquatic biodiversity

- Risk assessment of genetically improved aquatic organisms and the interaction between wild and cultured organisms should be conducted from ecological, biodiversity and stakeholder perspectives.
- Population genetics techniques should be used to enhance understanding and improve management of aquatic genetic resources, both in nature and in culture.

- Establishment of in situ and ex situ gene banks, including live, frozen and molecular material, should be encouraged and supported, as appropriate, and actively managed for documentation of the genetic resource, conservation, and for present and future use, e.g., in species recovery programs and as controls to selective breeding programs.
- Environmental and genetic sterilisation techniques should be developed, refined and used to reduce the chance of adverse impacts of cultured species on the environment.

4. Education of the general public on genetic technologies and principles

- There is a need for the standardisation of terminologies concerning genetics, genetic resources and technologies.
- Accurate and objective assessment of benefits and risks associated with the use of genetic technologies should involve all stakeholders and be communicated widely.
- Scientists should make proactive efforts to more accurately inform the popular print and electronic media in simple and easily understandable ways.

2.3.3 *Thematic Session 2.3: Aquaculture health management*

Chairpersons : Rohana P. Subasinghe and James F. Turnbull
Rapporteurs : David Alderman, Mike Hine, Mohammed Shariff , Peter Walker
Members : Victoria Alday de Graindorge, Craig L. Browdy,
Cristina Chávez Sánchez, Timothy W. Flegel, Brit Hjeltnes,
Celia Lavilla-Pitogo, Melba B. Reantaso,
Kamonporn Tonguthai, Snjezana Zrncic

Background and issues

- The private sector should work with the government in health management. A question was asked of evidence that effective regulation can help control the spread of aquatic diseases. The response was that regulation of oyster importation into the United Kingdom had effectively prevented the introduction of *Marteilia*. Other possible examples are the spread of disease by illegal importation, such as *Bonamia ostreae* into Europe and akoya oyster disease into Japan, and the illegal importation into the Philippines of *Penaeus monodon* and subsequent introduction of white spot syndrome virus (WSSV).
- The requirements of disease control by large commercial industries are very different from those of small subsistence farms. It is therefore difficult to generalise on how disease at different levels of industry can best be controlled. The many factors that affect aquaculture in different countries mean that each country has to design control methods in relation to its industries.
- It was pointed out that shrimp and fish should be treated differently. An example was given that the pleopods of shrimp can be used for PCR diagnosis of WSSV.
- The need for health and pathogen management was recognised, but good management practices can be difficult to implement. One innovative idea from Thailand is that farmers are encouraged to insure their stocks, the premiums being lower for those with good management practices, thus encouraging good health management. Care has to be taken in development of health legislation, and each disease may have to be addressed differently. However, it was pointed out that effective control policies keep out pathogens we are not aware of, as well as those that we are concerned with.
- These additional issues were also identified:
  - the massive economic losses sustained by aquaculture and their impacts on regions such as Asia and Latin America.
  - emerging diseases, use of antibiotics, discharge of waste, and pollution by chemotherapeutants and the spread of disease internationally with increase in world trade.
  - the problem of capacity building in developing countries.
  - the need to focus on all aspects of aquatic animal health, not only on pathogens.
  - the development of "fish links" between the aquaculture industry, diagnosticians and researchers.
  - the need to develop systems of compensation to encourage Cupertino between industry and authorities.
  - the need for intervention rather than identification, and prevention rather than treatment.
  - the need for a team approach to aquatic health management, involving scientists, regulatory authorities, stakeholders, lawyers etc.
  - the integration and harmonisation of health management at all levels, from the farm to international trade

Recommendations

- Appropriate and effective national and regional policies and regulatory frameworks on introduction and movement of live aquatic animals should be developed and enforced, with the view to reduce the risks of introduction, establishment and spread of aquatic animal pathogens.

Special attention should be given to capacity building, education and extension on aquatic animal health management, at all levels.

- The importance of aquatic animal health information gathering, processing and dissemination in reducing the risks of disease incursions in aquatic systems should be recognised, and effective and efficient national disease reporting systems, databases and other mechanisms should be developed and implemented.
- Technological development is a key to control and prevent aquatic animal diseases. Research on developing accurate and sensitive diagnostics methods, pathology and immunology, safe therapeutants, and effective disease control methodologies should be given high priority. In this respect, methodologies and techniques for the study of emerging diseases and pathogens should be given due consideration.
- A broad-spectrum systems approach to health management should be promoted, with clear emphasis on the benefits of using appropriate epidemiological tools, domestication procedures and maintaining biosafety.
- Governments need to look at low-cost options for disease control, such as industry self-regulation involving codes of practice, and also the harmonisation of regulations.
- Organisations such as FAO should assist in making available white spot-free broodstock. After spawning, the polymerase chain reaction (PCR) technique can be used on females to determine whether progeny, held separately after spawning, are infected with WSSV. However the sensitivity of the technique should be considered in relation to other techniques, stock history and sampling size.
- Serious diseases, such as WSSV, require expert task forces to develop global control strategies. A cost-effective method would be the creation of small expert groups on the diseases of finfish, crustaceans and molluscs. Such task forces would represent a body of expert opinion on global strategies for disease control, on the basic of scientific knowledge, independent of national or industry concerns. Each group would meet annually for a relatively short period (3 to 5 days) to develop global strategies for disease reduction, with milestones specified for each step. These groups would also have an overview of global problems and expertise, and would identify areas of Cupertino between laboratories in different countries. The recommendations from each group would be circulated to diagnostic and research workers for comment and the agreed-upon recommendations would be sent to relevant global organisations.

2.3.4 Thematic Session 2.4: Nutrition and feeding

Chairpersons	:	M.R. Hasan and Sadasivam Kaushik
Rapporteurs	:	Patrick Lavens and Albert Tacon
Members	:	Torbjorn Asgard, Stuart Barlow, Mali Boonyaratpalin, Freddy Ib, Santosh Lall, Oyvind Lie, Chawalit Orachunwong

Background and issues

- Nutrition and feeding play a central and essential role in the sustainable development of the aquaculture sector.
- Poverty alleviation remains a major issue in different parts of the world, and aquaculture is bound to play an ever increasing role; profit-oriented, feed-based aquaculture should not be considered as a conflicting or mutually exclusive practice.
- Feed and fertiliser resource availability and costs are bottlenecks for the development and expansion of small-scale aquaculture.
- Current usage and importance of marine fishery resources within industrially compounded aquafeeds is a cause for concern. While lack of fishmeal is not foreseen in the next 25 years, even at the current rate of aquaculture growth there is a definite risk of a shortage in marine oils in the short term (5-10 years).

Recommendations

- There is a need to have a better understanding of the dietary nutrient requirements of cultured species, including their application to practical culture conditions.
- There is a need to have a better understanding of the aquaculture farming system (extensive, semi-intensive or intensive; closed or open culture systems) and the potential nutrient loads and losses to the environment, and to maximise nutrient retention efficiency.
- There is a need to better understand and monitor the dynamics of nutrient flows and sinks within pond-based farming systems and to evaluate the presently available farm-made and commercial aquafeeds in small-scale pond culture.
- There is a need to improve the efficiency of resource use in aquaculture through the improved use of agricultural and fishery by-products/wastes and non-food grade feed materials, and to base feeding strategies, wherever possible, upon the use of renewable feed ingredients whose production can keep pace with the growth of the sector.
- There is a need to have a better understanding of nutrient bioavailability and the interactions of commonly used feed ingredients.
- There is a need to develop a better understanding of the mechanisms of nutrient modulation of disease resistance, as well as for improved strategies to minimise toxicity of nutrients and other compounds of feed origin.
- There is need to develop species-specific broodstock diets which allow complete domestication and maximal reproductivity and larval quality.
- There is a need to develop a better understanding of larval nutritional requirements in order to develop suitable compound diets, which will further reduce the need of live food.
- There is a need to promote the implementation of the FAO Code of Conduct for Responsible Fisheries through the development of technical guidelines in support of aquaculture development, and in particular, concerning "good aquaculture feed manufacturing practice" and "good on-farm feed management."

- There is a need to recognise the importance of feed and food safety issues (irrespective of the culture system) and growing consumer concerns, and a need for traceability of feed materials and production methods.
- There is a need to consider the effect of diet on product quality and the positive nutritional characteristics of the final product in terms of human nutrition (i.e., omega-3 fatty acids, iodine, selenium, zinc, calcium, phosphorus, vitamin A and D).

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2.3.5 Thematic Session 2.5: Enhancements including culture-based fisheries

Chairpersons	:	Kai Lorenzen and Deep B. Swar
Rapporteurs	:	Upali S. Amarasinghe and James M. Kapetsky
Members	:	Devin M. Bartley, Martin Bilio, Sena S. de Silva, Caroline J. Garaway, Wolf D. Hartmann, Jacques Moreau, V.V. Sugunan

Background and issues

- Enhancements are interventions in the life/rearing cycle of common-pool aquatic resources. Enhancement technologies include culture-based fisheries/ranching, habitat modifications, fertilisation, feeding and elimination of predators or competitors.
- Enhancements use little feed and energy, and often provide very high returns to input of labour and capital. This provides opportunities for resource-poor sections of the population to benefit from enhancements.
- Enhancements have an important role to play in generating food, income and wider benefits from under-utilised, new or presently degraded aquatic resources. At present, enhancements are estimated to yield at least 2 million mt/year, mostly in fresh waters, where they account for some 20% of capture, or 10% of combined capture and culture production. Marine enhancements are still at an experimental stage, but some have reached commercial production. Well-managed enhancements can lead to substantial increases in production over non-enhanced levels, as evidenced by e.g., the Chinese reservoirs or the Japanese scallop enhancements. A wide range of small-scale enhancements are initiated and sustained by rural people in developing countries, usually as a component in complex livelihoods.
- Enhancement initiatives can facilitate institutional change and a more active management of aquatic resources, leading to significant productivity, conservation and wider social benefits.
- Enhancements may help to maintain population abundance, community structure and ecosystem functioning in the face of heavy exploitation and/or environmental degradation.
- Negative environmental impacts may arise from ecological and genetic interactions between enhanced and wild stocks, and these are of particular concern where introduced species are used.
- Many enhancements have not realised their full potential because of failure to recognise the specific institutional, management and research requirements emanating from two key characteristics. Firstly, enhancements constitute investments in common-pool resources and can only be sustained under institutional arrangements that allow regulation of use and a flow of benefits to those who bear their costs. Secondly, technological interventions are limited to certain aspects of the life cycle of stocks, and outcomes are strongly dependent on natural conditions beyond management control. Hence, management interventions must be adapted to local conditions to be effective, and certain conditions may preclude successful enhancement altogether. The scope for "on station" or pilot-scale experiments to yield information on these issues is limited, and it is, therefore, crucial to analyse, and where possible, experiment with operational enhancements.
- Governments and supra-national organisations have a major role to play in facilitating enhancement initiatives through the establishment of conducive institutional arrangements, appropriate research support and the management of environmental and other external impacts on and from enhancements. A key role is to create conditions for resource users to actively support enhancements and assume management responsibility.
- Government support needs to strike an adequate balance between facilitating initiatives and regulation of environmental impacts on and from enhancements.

- Development of institutional arrangements to manage common-pool aquatic resources and sustain investment in them is crucial. Usually there will be a strong element of co-management where user organisations play an important role, frequently facilitated by various interest groups.

Recommendations

1. Approaches to management and development

- Government involvement, including research, planning and implementation, should be guided by the principles of participation and empowerment of resource users.
- Management and policy support for enhancements must be based on a production-systems approach integrating analyses of institutional arrangements, ecology, technology, marketing and socio-economics.
- Information and communication systems should be established to facilitate management and development, as well as regional and inter-regional Cupertino.
- Government and supra-national organisations should support development through comparative analyses, and facilitate adaptive learning.
- Development of enhancements should be integrated into watershed-level planning.
- Development of enhancement projects should follow international codes of practice on conservation and the sustainable use of biological diversity, as appropriate for local conditions. Key elements of these codes include environmental impact assessment, responsible use of introduced species and genetic resource management.

2. Research

- There is a need for:
  - Understanding the interactions between technical and institutional factors in determining outcomes of enhancements, and further development of adaptive learning approaches to deal constructively with uncertainties.
  - Understanding the biological, ecological and genetic dynamics of enhancements and developing appropriate methods for the assessment of technological management regimes.
  - Comprehensive and quantitative assessment of environmental impacts and risks of enhancements in relation to whole watersheds.
  - Considering and evaluating a wide range of enhancements and local resources; and developing new enhancement technologies.

3. Opportunities for regional Cupertino

- A key opportunity for regional Cupertino arises from a more pro-active approach to regional comparative studies, including identifying key opportunities for learning and for designing data collection and analysis programs specifically to meet these opportunities. This would involve:
  - training and capacity building in appropriate methods of institutional and technical analysis, e.g., Institutional Analysis (IAD), population and empirical modelling, and GIS.
  - regional data collection and dissemination using agreed-upon, standard methodologies.
  - regional data analysis and workshops to identify conditions conducive to enhancements, appropriate policies and management interventions.

2.3.6 Thematic Session 2.6: Systems approach to aquaculture

Chairpersons	:	Claude Boyd and Michael Phillips
Rapporteurs	:	Helen Dixon, Dan Fegan and Glenn Hurry
Members	:	Craig Browdy, Peter Edwards, Haydar Hasan al-Sahtout, Erik Hempel, Miao Weimin, Rafael Rafael, Peter Rogers, Marco Saroglia, Rohana Subasinghe, Siri Tookwinas, J.A.J. Verreth

Background

- The multi-disciplinary systems approach to aquaculture and its management is recognised to have considerable potential. The systems approach to aquaculture involves:
  - stating the problem.
  - identifying of the system.
  - classifying and describing the system boundaries and critical factors.
  - analysing the problem.
  - proposing solutions to the problem based on a systems understanding.
  - testing the solution.
  - implementing and disseminating knowledge on how to solve the problem.
- There are many different examples of the systems approach; some described by the panel members during the conference include:
  - applying the systems approach to small-scale farmer research and extension.
  - developing and applying best management practices.
  - improving the profitability of aquaculture operations.
  - identifying institutional responsibilities to assist in effective decision making at a regulatory/planning level.

Recommendations

- Industry codes of conduct and codes of practice have considerable potential. However, in developing and implementing such codes, special attention should be given to:
  - implementation issues and support.
  - allowing for continual improvement to take account of new information and technology.
  - the critical role of farmers in development and implementation.
  - mechanisms for regulation.
  - There is a need to develop and evaluate meaningful indicators to assist in understanding technical, environmental, social and other components of aquaculture and to improve management. The use of the "ecological footprint" model as a sustainability indicator was discussed, and it was suggested to develop better tools to provide indicators of resource use efficiency.
  - There is a need to communicate practical examples where the systems approach has been used and to incorporate the problem identification and solving systems approach into educational and training programs. Sharing of experiences and the use of the systems approach in education, training, research and development should be emphasised.
  - Promote the systems approach to aquaculture.
  - Emphasise the systems approach to improve aquaculture research and management.
  - Improve the tools available, and develop indicators for assessing technical, environmental, social and economic interactions.

2.4 Thematic Session 3: Aquaculture products: quality, safety, marketing and trade

Chairpersons	:	Helga Josupeit and Audun Lem
Rapporteur	:	Audun Lem
Members	:	Eric Hempel, Nik Mustafa Raja, Alan Reilly, S. Subasinghe, Srilak Suwanrangsi

Recommendations

- For long term viability and sustainability, commercial aquaculture development must be market driven, taking into account consumers' requirements.
- Trade in aquaculture products should be further liberalised, including the elimination of barriers and distortions to trade, such as duties, quotas and non-tariff barriers in accordance with the principles, rights and obligations of the WTO Agreement and other international agreements.
- The creation of efficient marketing systems, in which prices and costs are determined by supply and demand in order to ensure economic efficiency and sustainability, should be facilitated. Causes of market failure and unsustainable use of resources should be rectified through the use of economic incentives and disincentives.
- Standards applicable to international trade in aquaculture products should be harmonised in accordance with relevant internationally recognised provisions. On a national level, safety management systems including Good Agricultural Practice (GAP) and Good Manufacturing Practice (GMP), should be in place to ensure the production, distribution and sale of aquaculture products suitable for human consumption.
- Collection, analysis and dissemination of relevant information should be facilitated in order to enable producers and industry operators to make informed decisions and to ensure consumer confidence in the food safety of aquaculture products.
- Fish trade measures to protect human or animal life or health, the interests of consumers and the environment, should not be discriminatory and should be in accordance with internationally agreed-upon rules.
- Industry at each stage in the market chain must take primary responsibility in the production and distribution of safe aquaculture products and by-products, with due consideration of the polluter-pays principle.
- Production systems must allow traceability of product ingredients, including information on packaging, processing, harvesting, growing conditions and water quality, aquaculture stock, feed and health programs.
- Labelling of aquaculture products should follow recommendations and codes of practice in line with international requirements of the WTO and the *Codex Alimentarius*.
- Labels of aquatic feeds should include complete information on additives, growth promoters and all other ingredients, including the possible use of genetically modified organisms.
- Safety assessment based on risk analysis and the precautionary approach should be carried out prior to market approval, including products from modern biotechnology.
- International and interregional Cupertino in the field of safety, quality and trade in aquaculture products should be encouraged.
- Alternative market approaches, such as fair trade and organic farming, should be encouraged on a national and international level.

2.5 Thematic Session 5: Aquaculture development: financing and institutional support

Chairpersons : Cornelia Nauen and Ron Zweig
Rapporteurs : Richard Fuchs and Barney Smith
Members : Kirsten Bjoru, Simon Bland, Jeanineke Dahl-Kristensen,
Lennox Hinds, A.M. Jayasekara, Jia Jiansan,
Hassanai Kongkeo, Alessandro Piccioli, Malcolm Sarmiento

- Private sector funding makes a major contribution to aquaculture development, while public sector finance is important and can fill niches of capacity building and institutional development.
- Applied research and farmer access to knowledge are identified as areas needing particular attention.
- International development assistance is becoming increasingly directed towards poverty alleviation and needs to adhere to basic principles of social equity, including gender, environmental sustainability, technical feasibility, economic viability and good governance.
- The level of risk is important when supporting initiatives to address poverty elimination.
- Multiple projects increase the costs of development assistance and place a significant burden on national resources. A program approach makes it necessary for donors to more effectively cooperate and collaborate with each other. Ultimately this needs to occur within comprehensive frameworks. There is thus a need for donors to adopt more cohesive approaches and procedures.

3 ANNEXES

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3.1 Annex 1: List of Participants

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3.2 Annex 2: Conference Programme

Registration: 10.00–17.30, Sunday 20 February
08.00–17.00, 21and 22 February

Time	Activity
20/02/2000	
Inaugural Ceremonies	
15.30 – 16.30	**Conference Opening Ceremony** Arrival of dignitaries Introductions (Master of Ceremonies) **Welcome speeches** Secretary-General of the Conference FAO Assistant Director-General and Regional Representative for Asia and the Pacific NACA Governing Council Chairman Director-General, Department of Fisheries, Thailand **Keynote Speech** The Honourable Mr. Pongpol Adireksarn, *Minister of Agriculture and Co-operatives, Thailand*
16.30	**Trade Fair Opening Ceremony** Opening by the Hon. Mr. Pongpol Adireksarn Tour of Exhibitions **Speeches** Hon. Mahinda Rajapakse, *Minister of Fisheries, Sri Lanka* Hon. Dr Nguyen Viet Thang, *Vice Minister of Fisheries, Vietnam*
18.00	Welcome Reception - Hosted by NACA
21/02/2000	
08.45	**Introduction to the Conference** Rohana Subasinghe, *FAO Rome*
09.00	Keynote Address 1: From Kyoto 1996 to Bangkok 2000 T.V.R. Pillay, *India*
09.30	Keynote Address 2: **Aquaculture beyond 2000: Global Prospects** Jia Jiansan, *FAO, Rome*
10.00	Break
Session I:	**Global and Regional Overviews of Aquaculture Development and Trends** *Chairs:* Sena de Silva, *Deakin University, Australia* Laszlo Varadi, *HAKI, Hungary*
10.30	**Aquaculture development in Asia and the Pacific countries** Hassanai Kongkeo, *NACA, Bangkok* Pierre Labrosse, *South Pacific Commission, New Caledonia*
11.15	**Aquaculture development in China** Wang Yanliang, *Bureau of Fisheries, Ministry of Agriculture, China*
11.45	**Aquaculture development in Latin America and the Caribbean** Manuel Martinez-Espinosa, *FAO, Rome*
12.30	Lunch
14.00	**Aquaculture development in Africa** Matthias Halwart, *FAO, Rome*
14.30	**Aquaculture development in the Near East** Krishen Rana, *FAO, Rome*
15.00	**Aquaculture development in northern America** Paul Olin, *University of California-Sea Grant, USA*
15.30	Break

Time	Activity	
16.00	**Aquaculture development in Eastern Europe and the former USSR** Ferenc Pekar, *Fisheries Research Institute, Hungary* (Supplementary presentation on status of aquaculture in Ukraine V.N.Ivanov, *Institute of Biology of the Southern Seas, Sevastopol*)	
16.30	**Aquaculture development in Europe** Laszlo Varadi, *Fisheries Research Institute, Hungary*	
17.00	**Global perspectives for aquaculture in the new millennium** Sena de Silva, *Deakin University, Australia*	
18.00	Sessions Close	
22/02/2000		
08.45	**Opening of session and introduction of plenary speakers** Hassanai Kongkeo, *NACA, Thailand*	
09.00	Plenary Lecture 1: **Policy-making and planning for sustainable aquaculture development** Ulf Wijkstrom, *FAO, Rome*	
09.45	Plenary Lecture 2: **Technologies for sustainable aquaculture development** Patrick Sorgeloos, *University of Ghent, Belgium*	
10.30	Break	
	Session II: **Policy-making and planning for sustainable aquaculture development**	*Session III:* **Technologies for sustainable aquaculture development**
11.00	Group 1: **Increasing the contribution of aquaculture for food security and poverty alleviation** Chairs: Albert Tacon, *Oceanic Institute, USA* M.C. Nandeesha, *CARE, Bangladesh*	Group 1: **Aquaculture systems and species** Chairs: Harald Rosenthal, *Institute of Marine Sciences, Germany* Laszlo Varadi, Fisheries *Research Institute, Hungary*
12.30	Lunch	
14.00	Group 2: **Integrating aquaculture into rural development in coastal and inland areas** Chairs: Chua Thia Eng, *IMO, Philippines* Simon Bland, *DFID, U.K.*	Group 2: **Genetics in aquaculture development** Chairs: Kshitish Majumdar, *India* Rex Dunham, *Auburn Univ., USA*
15.30	Break	
16.00	Group 3: **Involving stakeholders in aquaculture policy-making, planning and management** Chairs: Sevaly Sen, *Australia* Edwin Rhodes, *NOAA, USA*	Group 3: **Aquaculture health management** Chairs: Rohana Subasinghe, *FAO, Rome* James Turnbull, *University of Stirling, UK*
17.30	Sessions Close	Sessions Close
23/02/2000		
08.45	**Opening of session and introduction of plenary speakers** Rohana Subasinghe, FAO	
09:00	Plenary Lecture 3: **Regional and inter-regional co-operation for sustainable aquaculture development** Lennox Hinds, *CIDA, Canada*	
09.45	Plenary Lecture 4: **Human resource development (training, education, and extension) for sustainable aquaculture development** Sena de Silva, *Deakin University, Australia*	
10.30	Break	

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Time	Activity	
	Session II: **Policy-making and planning for sustainable aquaculture development** *(cont'd)*	Session III: **Technologies for sustainable aquaculture development** *(cont'd)*
11.00	Group 4: **Promoting sustainable aquaculture through economic incentives** Chairs: Rolf Willmann, *FAO, Rome* Jason Clay, *WWF, USA*	Group 4: **Nutrition and feeding** Chairs: M. Rezaul Hasan, *Bangladesh Agricultural University* Sadasivam Kaushik, *Fish Nutrition Laboratory, France*
12.30	Lunch	
14.00	Group 5: **Establishing legal institutional and regulatory frameworks for aquaculture development and management** Chair: Annick van Houtte, *FAO, Rome*	Group 5: **Culture-based fisheries and enhancement** Chairs: Kai Lorenzen, *Imperial College, UK* Deep Swar, *Nepal*
15.30	Break	
16.00	Group 6: **Building the information base for aquaculture policy-making, planning and management** Chairs: Jorge Calderon, *CENAIM, Ecuador* Yong Ja Cho, *Republic of Korea*	Group 6: **Systems approach to aquaculture management** Chairs: Michael Phillips, *NACA, Thailand* Claude Boyd, *Auburn University, USA*
17.30	Sessions Close	Sessions Close
24/02/2000		
08.45	**Opening of session and introduction of plenary speakers** Jorge Calderon, *CENAIM, Ecuador*	
09.00	Plenary Lecture 4: **International trade – issues and challenges** Helga Josupeit, *FAO, Rome*	
09.45	Guest Lecture: **Agriculture and livestock production: a model for aquaculture development?** Robert Swick, *American Soybean Association, Singnpore*	
10.30	Break	
11.00	Session IV: **Aquaculture products: quality, safety, marketing, and trade** Chairs: Helga Josupeit, *FAO, Rome* S. Subasinghe, *INFOFISH, Malaysia*	
12.30	Lunch	
14.00	Session V: **Aquaculture development: financing and institutional support** Chairs: Ronald Zweig, *World Bank, Washington* Cornelia Nauen, *EC, Brussels*	
15.30	Break	
16.00	Session VI: **Summary presentations:** **recommendations of discussion sessions**[1]: Chairs: Jia Jiansan, *FAO, Rome* Hassanai Kongkeo, *NACA, Thailand*	

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[1] All synthesis presentations will be 20 minutes + 10 minutes discussion

Time	Activity
16.00	**Policy-making and planning for sustainable aquaculture development - *Groups 1-3***
16.30	**Policy-making and planning for sustainable aquaculture development - *Groups 4-6***
17.00	**Technologies for sustainable aquaculture development - *Groups 1-3***
17.30	**Technologies for sustainable aquaculture development - *Groups 4-6***
18.00	Sessions Close
20.00	Conference Dinner Hosted by the Department of Fisheries, Thailand and Charoen Phokpand Company, Ltd.
25/02/2000	
	Session VI *(Cont'd):* **Summary presentations (recommendations) Session syntheses:** Chairs: Jia Jiansan, *FAO, Rome* Hassanai Kongkeo, *NACA, Thailand*
09.00	*Session synthesis* **Aquaculture products: quality, safety, marketing and trade:** Audun Lem, *FAO Rome*
09.30	*Session synthesis* **Aquaculture development: financing and institutional support** Ron Zweig, *World Bank*
10.00	Discussion
10.30	Break
11.00	**Asian regional aquaculture development action plan and strategy**[2] Pedro Bueno, *NACA*
11.45	**Strategies for Inter-regional co-operation for sustainable aquaculture development**[3] Chairs: Glenn Hurry, *Australia* Rohana Subasinghe, *FAO, Rome*
12.30	Lunch
	Session VII: **Conclusions** Chairs: Director-General of Fisheries, Thailand Minister of Fisheries, Sri Lanka Vice Minister of Fisheries, Vietnam
14.00	**Presentation of draft Declaration and Strategy and discussion on next steps**
14.45	**Adoption of Declaration and Strategy and conclusion of the Conference**
15.30	Conference Ends

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[2] Presentation of NACA's Asia Regional Aquaculture Development Action Plan and Strategy.

[3] A session to discuss possible future inter-regional cooperation activities based on the conference discussions.

3.3 Annex 3: Speech by Mr. Hassanai Kongkeo, NACA Coordinator and the Secretary General of the Conference

Honourable Minister of Agriculture of Thailand, Mr. Pongpol Adireksan; Your Excellencies; Distinguished Delegates; Colleagues in Fisheries Development:

It is my privilege to welcome you to this conference, which is one of the first major and global discussions on aquaculture development in this newly arrived third millennium. Conceiving, preparing for and organizing the conference has been a long process involving the cooperation of many people, groups, organizations and governments. This very spirit of cooperation has been the hallmark of the region's push towards aquaculture development. It has paid off in one of the highest growth rates recorded in any food production sector. This conference is the sequel to the Kyoto Conference held nearly 25 years ago. Both owed their conception to the same person. And I would like to start a long list of acknowledgements with that person, Dr Ramu Pillay, the architect of Kyoto 1976 and - for lack of a better word – the mover of Bangkok 2000. After him are those that have played key responsibilities in the events that have led to this opening ceremony.

I will begin with the NACA leadership before and during 1990, including the Coordinator and the Governing Council, who placed in NACA's first 5-year regional work programme an International Conference on Aquaculture. This idea suggested a huge undertaking for a young, newly independent NACA. But it was subsequently given form and substance by Dr Pillay, the NACA governments and the NACA secretariat with the inputs and assistance of many friends of NACA. The Governing Council – convinced of the importance to their countries and the urgency to the region of another strategy-setting regional, if not global exercise – strongly endorsed the activity and gave it high priority. The idea of a conference made a great leap towards reality when FAO – which, as we all know, was the organizer, along with the Government of Japan, of Kyoto 1976 – strongly supported the plan and offered to cooperate with NACA. The Department of Fisheries of the Government of Thailand generously came forward to host the event, including the Aquaculture and Seafood Fair.

A significant undertaking such as this conference and the trade fair must need a significant amount of support and inspiration to succeed. These came in generous doses from many individuals and organizations. It is with pleasure for me to acknowledge Patrick Sorgeloos, current president of the World Aquaculture Society, who was instrumental in bringing the support from the European Union. We appreciate that this was not alone a personal gesture of Patrick, but embodies that of the WAS, which he represents.

The Government of Australia, particularly the Agriculture, Forestry and Fisheries - Australia, assigned to the Conference Secretariat one of the most hardworking young persons. Along with his services, the department provided material contribution for other activities.

The strong social orientation of the objectives of the conference attracted the interest of a number of organizations with large social development components in their programs. One is the Canadian International Development Agency, which gave a grant to enable policy makers and planners from other developing regions to take part and share views with their Asian counterparts. I wish to thank Lennox Hinds for initiating this CIDA assistance and Brian Davy for providing a strong endorsement of NACA to the agency.

The Rockefeller Brothers Fund very generously came forward to offer assistance for a number of talented and dedicated individuals with no big mother organization to support them. The name "Rockefeller" sounds formidable, but thanks to another friend of NACA who works with the institution and has devoted a substantial amount of his time and talent in working with the poor areas and threatened environments of Southeast Asia, the conference has benefited from its assistance to social development causes.

With an environmental *cum* social-economic development thrust, the conference gained the attention and support of a program in the Word Bank that has given collaborative assistance to a major program of NACA as well. We appreciate very much the assistance of Ron Zweig, who provided, through the

World Bank - Netherlands Partnership Programme, the facility to bring a number of workers from several countries that are trying to find ways to make shrimp farming a more socially responsible activity. I also would like to mention, in the same regard, the various suggestions and assistance from another NACA friend who works with the World Wide Fund for Nature.

The office of the Conference Secretariat shares its premises with a regional project of the Danish Center for Environment and Development. The project director, Don Macintosh, and his staff have shared much of their time and resources in carrying out this conference. I wish to record my appreciation to DANCED, through its tropical coastal ecosystems program, for the innumerable material, professional and moral support given to the secretariat.

Innumerable also describes the help from NACA's parent organization and now partner in this and other activities - the FAO. Our colleagues in the Fisheries Department of FAO in Rome, as well as the Regional Office in Asia Pacific here in Bangkok, have provided innumerable assistance and inspiration. It was extremely pleasant to work with them, helped a lot by the spirit of warmth, friendship and respect that prevails. It is with much gratitude that I acknowledge their cooperation.

Finally, I wish to express our gratitude for the many forms of assistance received from various other organizations, groups and persons. I would like to thank SEAFDEC, with whom we share our house and other useful resources, and its Aquaculture Department for their help in a number of activities; AIT, for the many professional and personal assistance extended to us; Kasetsart University for expert assistance in the management of the conference, the Lead Centres and several institutions in the NACA network for their technical assistance and advice; ICLARM – which despite the very difficult and time consuming task of transferring headquarters, have come with their topnotch staff headed by the Director General herself to serve in the panels; and the various projects assisted by DANIDA, particularly those of the Mekong River Commission, for supporting the participation of a number of their staff and project beneficiaries. As to the trade fair, we deeply appreciate the participation of business and industry in Thailand and other countries.

I reserve the final acknowledgements to the governments, and my most heartfelt thanks to the friends of NACA. They brought into the planning of this conference their vast and rich experience in national, regional and global aquaculture management and development.

To all of you and your organizations, I wish to record our gratitude. My friends, welcome to the Conference on Aquaculture in the Third Millennium.

3.4 Annex 4: Speech by Mr. Dong Qingsong, Officer-in-Charge, FAO Regional Office for Asia and the Pacific

H.E. Mr. Pongpol Adireksarn, Minister for Agriculture and Cooperatives, Royal Thai Government; Mr. Dhammarong Prakobboon, Director-General of the Thai Department of Fisheries; Mr. Hassanai Kongkeo, NACA Co-ordinator and Secretary-General of the Conference; Distinguished Delegates; Ladies and Gentlemen:

First of all, allow me to convey the warm greetings and best wishes of FAO Director-General, Dr. Jacques Diouf, and on his behalf, I would like to welcome you all to the Conference on Aquaculture in the Third Millennium.

All of us have shared the excitement in greeting the New Year all over the world. We are now entering into the Third Millennium, a new millennium for our progress and prosperity. To ensure continuous progress, however, the "Agenda for Action" is required in order to guide us into the right path – not to the end of the millennium, of course, but rather, to the end of this or the next decade for the benefit of our children - and this is the primary objective for the conference.

Excellency, Ladies and Gentlemen,

Fish contribute a significant amount of protein to the diets of people world-wide. Recent estimates of fish consumption by FAO indicate consumption as high as 175 kg per head in the Maldives to as low as one kg in Nepal, compared to the global average of 15 kg. While the stagnant growth in capture fisheries production in the last decade has been observed, aquaculture production continues to increase at a rapid rate. The production has more than tripled in only 15 years i.e., from 10 million tons in 1984 to more than 36 million in 1997. Aquaculture shares, therefore, will be one of the main sources of protein for our people, particularly in rural areas all over the world, in the years to come. It will support our efforts in alleviating global poverty and improving food security, as agreed at the World Food Summit in 1996.

In order to accelerate further development of aquaculture, FAO has worked closely with NACA to promote sustainable aquacultural practices and to develop strategies to facilitate its growth in an environmentally and socially responsible manner. To this end, FAO and NACA are proud to co-sponsor this conference, which is hosted by the Department of Fisheries of Thailand, with the objective of developing a global strategic plan for aquaculture development in the next decade. I sincerely hope that all delegates will have the opportunity to discuss and contribute toward this noble goal at this conference.

Before closing, I wish to express our appreciation for your presence at this conference. I wish to thank NACA and the Department of Fisheries for their excellent arrangements for the conference; and I wish you all a success in your deliberations and a happy sojourn in this beautiful City of Angels.

3.5 Annex 5: Speech by Mr. A.M. Jayasekara, Chairman, NACA Governing Council

Distinguished Guest of Honour, Minister Pongpol Adireksan; Your Excellencies; Fellow Delegates:

It is a distinct privilege to take part in this conference and welcome you on behalf of the NACA Governing Council. Sri Lanka, which I represent in the council, is honoured by its current chairmanship of the council. In this capacity, I would like to thank FAO for its support and Cupertino as a partner in this endeavour, and the Government of Thailand for hosting the conference and the Aquaculture and Seafood Fair. The governments of NACA - and their private farming sectors - have enjoyed the tremendous benefits from a long-range strategic planning for aquaculture development. We were made aware of the importance of aquaculture in social and economic development. We were given the basic tools for improving the production technologies and production systems, as well as the capability for planning and managing the development of a young sector. We were made aware, and have justifiably harvested the rewards, of Cupertino. And, of no small significance to the members that have to cope hard with the task of feeding a growing population and improving the net-worth of a modest economy, we were given the ultimate reward of seeing increasing yields, productivity, and income.

In this regard, the governments had endorsed, with unity and without reservation, the plan for holding this conference on aquaculture, and pledged their usual commitment and support to its completion. As part of the preparations, the governments held a regional planning exercise in September of last year. The result was a first draft of a blueprint for Asian regional aquaculture development in this new century. The draft plan is to be enriched, guided and completed with the integration of the recommendations of this conference. The governments, therefore, have very high expectations from this conference. The draft regional plan for Asia reflects the governments' continuing priorities for the basic development goals, including higher production, better nutrition, more jobs and better income for people and, on the whole, a better economy. To us, the tools to attain these need to be sharpened and made even more effective. Governments make no excuses for wanting bigger harvests to feed people and better products and prices for them to earn more. Having said this, governments are also keenly aware that a bigger harvest should not come at the expense of a ruined environment and an impoverished resource-base, and that the harvest should be shared equitably by those responsible for producing it. The Kyoto Strategy for Aquaculture Development has shown that a good dose of science spread around economically and efficiently though regional Cupertino can go a long way towards attaining huge harvests of cultured fish. This conference - from the governments' standpoint – should now provide the strategy for a global Cupertino in sustaining the gains from Kyoto 1976 and sustaining the environment. The lessons from the past 24 years are there for the learning, and this conference should provide the opportunity for every one here to pool experiences and learn from this pool, which is made rich by the tremendous breadth in experience and depth of talent of the participation in this conference.

I would like to end by reiterating the words of gratitude expressed by the Secretary General of the conference and NACA Co-ordinator, as well as to commend him and his hardworking staff and associates for the excellent preparations.

I wish us all a productive and rewarding meeting.

3.6 Annex 6: Speech by Mr. Dhammarong Prakobboon, Director General for Fisheries, Thailand

Honourable Minister, Mr. Pongpol Adireksan; Honourable Minister, Mr. Mahinda Rajapakse of Sri Lanka; Honourable Vice Minister Dr. Nguyen Thang of Vietnam, Mr Dong Qingson of the FAO; Your Excellencies; Fellow Delegates; Friends, Ladies and Gentlemen:

As host of this conference, the staff of the Department of Fisheries and I would like to welcome you to the conference and to our country. This conference is very important to us, because it will be helpful in directing our research and development programs. As you know, Thailand depends much on aquaculture for food, employment and export. We have spent much effort and resources to develop the technologies. Now we are putting more to make it sustainable. We have shared our experience and technologies with many other countries - especially through the NACA system - and we have benefited from this Cupertino. We look forward to this conference providing guidelines to improve further our aquaculture so that it will fulfil the needs of our people, especially the poor.

To our honourable guest speaker, I am very pleased to report on behalf of the organisers that the conference has a wide participation. There are about 600 delegates representing almost 70 countries and more than 200 organisations, agencies, institutions and societies, including non-government, industry, business and farming groups. In short, all the important stakeholders are here for the conference.

The Aquaculture and Seafood Fair – which you are requested to inaugurate also this afternoon – has also a wide, varied and interesting offering. There are a total of 72 booths and stands set up by 51 companies, organisations and societies from 15 countries. The displays include a range of new products, better technologies, new materials, useful ideas and services for progressive and profitable aquaculture. A range of interesting ornamental species are on display. Many of these are products of the farmers of Thailand who have received technical assistance by the Ministry of Agriculture from the Fisheries Department. We also are displaying the various activities and publications of the Fisheries Department.

We are extremely honoured by your presence. We thank you for graciously consenting to set the tone for the conference with a keynote address.

I would like to end by thanking NACA and FAO for the opportunity to be their partner in organising this important event. Again, welcome to all of you; I look forward to a fruitful conference.

Ladies and gentlemen, it is my honour to introduce to you our distinguished guest speaker, Honourable Minister Pongpol Adireksan.

3.7 Annex 7: Keynote Address by Mr. Pongpol Adireksan, Minister of Agriculture and Co-operatives, Thailand

Distinguished Delegates, Your Excellencies, Ladies and Gentlemen:

It is my privilege to welcome you to the Kingdom of Thailand for this important conference on "Aquaculture in the Third Millennium". I hope you had a pleasant journey to Bangkok and that your stay will be fruitful and memorable.

I should like to thank the organisers, the Network of Aquaculture Centres in Asia-Pacific and the Food and Agriculture Organization, for the invitation to address this conference.

I am gratified to take part in this global meeting on aquaculture development. It deals with a subject that is woven into the social, cultural and economic fabrics of Asian societies. Fish is a staple food of our people and its capture and culture provide direct livelihood to hundreds of thousands of families along the coasts and around inland waters and ponds, and to millions more that are providing support to its sustained development. Its production and commerce bring good income to the people and the country. I know you will be provided the detailed information and updated figures on Thai aquaculture. You will know then that the culture of marine shrimp in this country is the largest in the world, supplying almost a third of the world's production, earning for the national economy two billion dollars a year from its sale, and generating in employment and additional business opportunity a sum four times that figure.

The status that we have achieved as the foremost farmer of marine shrimp has, obviously, also come with costs. I have absolutely no doubt you know this. Many of you would be intimately familiar with the lessons - some good, others bad – that our efforts at producing this commodity can offer. We take pride in our achievements, but we will humbly submit to your advice. As one who represents a group collectively called "policy makers" - that useful class of people who takes the fall for every perceived mistake of government – I would like to assure you that the conclusions of, and directions offered by, this conference will be seriously and post-haste taken up by the government.

May I hasten to remind you, however, that the Kingdom's aquaculture industry is – as with the rest of Asia – diverse. The 300,000 or more people farming our fresh waters produce nearly a third of a million tons of 15 types of fish and prawn from the 72 thousand hectares of inland freshwater bodies all over the country. Along the lengthy coasts, people are raising a variety of fish, shellfish and aquatic plants to augment their income from elsewhere, but mainly from fishing. This is an important point to remember in the face of the increasing number of people who would like to fish and the decreasing quantity of wild fish. Our freshwater aquaculture, especially that of a number of native fishes like snakehead and catfish, has been said to be one of the strongest and advanced among the developing countries of Asia. For this reason, the Network of Aquaculture Centres in Asia-Pacific had chosen Thailand's inland fisheries research centre as one of four lead aquaculture centres in its regional network.

Our scientists and technicians have served the network well. In the spirit of Cupertino among Asian governments, they have also learned a lot of useful technology and ideas from their peers in other countries. This give-and-take has served Asian economies well. We have benefited from our respective strengths, and strengthened our capacities even more by sharing resources and experiences and by pooling our scientific talents.

Thailand has much to thank all nations and concerned participants from this Cupertino and from various forms of assistance. From the prudent application of external assistance and local resources and expertise, our fish-farming industry has progressed to being considered as one of the pillars of the economy, providing fifteen percent of the total fish supply and forty percent of the value of that supply. However, we are acutely aware that many forms of activities have created serious impacts on our aquatic resources and environments, with fisheries being stretched to the limit of capacity and our fishers pushed hard to find enough fish. Environmental changes in coastal areas in particular adversely affect the coastal communities that rely on these resources, creating a vicious circle of habitat destruction and declining livelihood. The government is acutely aware of such problems and is giving a high priority to environmental rehabilitation, such as the Thai Seas Rehabilitation Project and various mangrove forest replanting schemes, even under what have been economically troubled times. We are also aware of the need for aquaculture to meet the looming shortfall between human demand for aquatic products and their supply. Fishing grounds are over-fished, so that we are looking at aquaculture as an essential means to make up for lost production from capture fisheries, and to provide employment and livelihood to people dependent on capture fisheries.

Thailand's success in aquaculture and, for that matter, agriculture owes much to the vision and guidance of our King. His Majesty has shown a special interest in aquaculture. He has promoted the concept of integrated farming and water storage through ponds in small-scale farms. He introduced the tilapia, and his prowess in fish breeding led to the special "ruby fish" which is now being marketed in other countries. (I hope that our friends in CP will serve this fish to you during the conference). His well-known and well-studied project in Kung Krabaen on our eastern seaboard has also provided an excellent model of how mangroves and shrimp aquaculture can be integrated into one successful rural development program that benefits the local people. His many initiatives, invariably demonstrated by his own deeds, have provided the proper direction and examples to Thailand's efforts at rural aquaculture development.

Thailand is also committed to regional and international Cupertino. We are proud to be the host of NACA and the Southeast Asian Fisheries Development Centre or SEAFDEC, two of the leading organisations in fisheries development Cupertino in the region, and the Asian Institute of Technology or AIT, a leading graduate school in sciences and technology with a strong academic and development program in the aquatic sciences and in resource management. Needless to say, we are also host to the regional office of FAO, which has provided many an initiative and technical guidance that have considerably improved Thailand's fisheries and aquaculture. FAO and UNDP, in fact, gave birth to NACA. NACA and SEAFDEC, as well as AIT, were proposed and formed in fora that the Government of Thailand had taken active part, in tandem with other countries in this region. The spirit behind these organisations is mutual respect and equality among their members, and their driving force is the recognition of mutual benefits – in promoting prosperity and maintaining peace – derived from Cupertino. I have no doubt that the same spirit will pervade your deliberations.

I understand that this conference is a long overdue sequel to the first global Technical Conference on Aquaculture, held in Kyoto, Japan in 1976. It is indeed gratifying to see that the number of countries represented and the number of people attending far exceed those of Kyoto. The Kyoto Conference provided that impulse for world aquaculture development and, thanks to that first conference, there has been kindled a strong and sustained interest in aquaculture. This is indicated by the wider representation in this second conference, although one can also argue that it also reflects the increasing number and diversity of concerns

We know aquaculture affects the welfare of many families and communities. With the predicted stagnation in fisheries and the increase in populations, the health of aquaculture will impact on even more people more profoundly. Aquaculture is built into the socio-economic fabric of Asian societies. Therefore, we will have to continue to nurture the sector to the best of our ability to ensure that it remains viable and sustainable and gives the best returns to society. You need no reminding of the many challenges and pitfalls awaiting aquaculture development efforts, and of the huge task to be carried out to meet the challenges and surmount obstacles.

But I would like to express my gratitude on behalf of the government for your efforts in and commitment to its development. This convergence of a wide range and deep pool of scientific, technical and managerial talent is reassuring. The importance given to this subject, I believe, is the reason many of you have travelled long distances to take part in this conference. I have been informed there are 70 countries and territories represented here and more than 600 delegates. It is a pleasure for me to see people from so many countries representing different sectors and interest groups coming together for this conference. This is important, because successful aquaculture development requires a thorough and wide involvement - and bold but reasonable action - in its science, management and politics. It also needs a concerted action among different government agencies, as well as the commitment and interest of the local people.

The Thai Government is keenly interested in the outcome of the conference. I would like to assure you that Thailand will give a high priority to participating in the follow-up activities. I expect the conference to provide an effective strategy and innovative and pragmatic ideas that will assist Thailand. All of us with a common interest in sustainable aquaculture should endeavour to make it contribute even more to the development of rural communities and provide a continuous source of aquatic food and material for our people. It is my privilege to interact with scientists and technical experts such as you; I find it a valuable and treasured experience.

However, the layman that I am, you will please bear with me if I request you to make your recommendations practical, workable and in terms that I might be able to understand.

I would like to thank NACA and FAO for joining hands with the Government of Thailand in organising this world conference. On behalf of the government, I wish to convey our appreciation to the organisations that have lent valuable support and inspiration.

I wish you an enjoyable and successful meeting and a pleasant stay in Thailand. It is my pleasure to now declare the conference and the Aquaculture and Seafood Fair open.

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3.8 Annex 8: Introduction to the Bangkok Declaration and Strategy by Mr. Glenn Hurry, Assistant Secretary for Agriculture, Forestry and Fisheries, Australia; Co-Chairman of the Technical Drafting Committee

The Director General of Fisheries, Thailand; The Minister of Fisheries, Sri Lanka; Dr Ramu Pillay; Mr. Hassanai Kongkeo; Ladies and Gentlemen:

Coming from a country with a small but increasingly important aquaculture industry, it is a very great privilege to have been asked to co-chair with Chen Foo Yan, the Technical Drafting Committee and to present to you today the Bangkok Declaration on Aquaculture. With this Declaration are the key elements that countries can incorporate when developing strategies for aquaculture development for the next 20 years.

It has been a pleasure to work with Chen Foo Yan and the members of the Technical Drafting Committee, who were drawn from a diverse range of countries and backgrounds, and I thank them for their commitment and contribution. It has also been a pleasure to work with you, the participants of this conference, to bring together this Declaration. Bear with me while I find a way through this afternoon's session.

The Honourable Minister of Agriculture and Co-operatives Fisheries in Thailand, in his opening speech on Sunday, left this conference with a request, that the outcomes be practical, workable and able to be understood by the people who have to implement them. This is a global conference with some 600 participants and, in a way, the request presented a reasonable challenge. However, over the last five days we have tried to reflect a Declaration and key elements for aquaculture strategies that provide a workable model for aquaculture development for the next 20 years, and one I trust is workable, flexible and understandable.

It will not meet everyone's individual preferences for wording, text and comment. In trying to develop a strategy to move a sector such as aquaculture forward in a global sense over a 20-year period, it never will. To develop a broadly acceptable text from this conference requires a degree of compromise and conciliation from us all. What is important is that the key issues and broad strategic directions are incorporated to provide the framework within which individual countries can tailor their own plans for the development and integration of aquaculture.

A Declaration on Aquaculture for the next 20 years cannot be mediocre. It must be strong enough to address the key issues confronting the future of aquaculture. A weak approach that avoids issues will not give aquaculture a sustainable future. While we cannot walk away from the lessons of the past 25 years, nor can governments, civil organisations, regulators and other interest groups ignore the valuable contributions that aquaculture has made and will continue to make, to global food production and security, trade and national development. We may not like policy and enforceable regulation, but demonstrating transparency in decision making and being able to account for the good stewardship of the use of natural resources will be key elements of future aquaculture and fisheries management.

In presenting this Declaration and Strategy for discussion and adoption, I would suggest that we agree to the draft text, subject to any additional comments from the floor today or any lodged in writing with the Secretariat by the end of the conference. I will move through the text of the Declaration and the key issues of the Strategy, and then open the floor for comments. We do not have a lot of time, and we will not debate the issues raised. Comments will be noted by the rapporteurs and referred, along with any additional written comments, to the drafting committee for inclusion in the final document, where and if appropriate. Comments have already been received and taken into account from some 27 individuals and organisations.

The document is in five sections, and the largest section that represents the key elements for aquaculture strategies is long, but is needed to reflect the recommendations of the sessions. These have been reflected in the key elements, along with the written comments, and will be available in full along with the final document.

We requested on Wednesday that comments provided be conceptual and constructive, and I now repeat that request.

I am mindful that this has been a long week, however, before I start with the Declaration, let us return briefly to Kyoto in 1976. There are a number of people here today who were at that conference. I think history will record that the *Kyoto Declaration on Aquaculture* was one of the most important documents in the development of aquaculture. That aquaculture has grown and benefited economies and people in many global areas is a credit to the vision and commitment of those involved.

The following then, is the text of the Declaration and the key issues for future strategies.

In closing I have a number of people to thank. Dr Ramu Pillay, you were instrumental in Kyoto, and you have provided the spark, vision and encouragement again for us to come together here in Bangkok this week. Your contributions to aquaculture around the world have been enormous. On behalf of all of us, I would like to convey our thanks to you for your continued commitment and guidance.

Our thanks and gratitude to the Royal Government of Thailand and the Thailand Department of Fisheries. Your continued contribution to aquaculture by providing a home and continued support for a number of important regional organisations and for hosting this conference is greatly appreciated. To Hassanai Kongkeo and his hard working team at NACA, our many thanks. I know this has not been an easy task for a small team, but to each and everyone of you, thanks for your commitments and contribution. And finally, thanks to all of the institutions and agencies that provided the funding and staff to support this conference and made it such an enjoyable and productive week.

This then, ladies and gentlemen, is our Declaration and Strategy. It is now your time. This Declaration reflects our commitment to aquaculture over the next 20 years. As the guidance for the last 25 years has been provided from the vision of Kyoto, it is now time for you to provide the guidance and vision for the next 20 years. The next 20 years will, no doubt, see many challenges in food producing systems and in balancing the use of natural resources. It will also provide many benefits from improvements in communication, science and technology. I would ask all those who are involved in, and benefit from, aquaculture that you embrace this Declaration and take it forward and importantly, that you do so with the commitment and courage to do and say what is right and necessary to ensure that aquaculture fulfils its potential.

For at the end of the day it will be your courage, your flexibility, your commitment and your integrity, and not self interest or self promotion that will make the vision of this, "The Bangkok Declaration on Aquaculture," a reality.

Thank you.

3.9 Annex 9: List of Keynote Papers, Reviews and Plenary Lectures Presented at, and Technical and Experience Papers Submitted to, the Conference

I. Papers presented at the Conference

A. Keynote papers

1. From Kyoto 1976 to Bangkok 2000, *T. V. R. Pillay*
2. Aquaculture development beyond 2000: global prospects, Jiansan *Jia*

B. Regional reviews

1. Asian aquaculture: trends, issues and prospects, *Hassanai Kongkeo*
2. Current status of aquaculture in the Pacific Islands, *Tim Adams, Johann Bell and Pierre Labrosse*
3. Aquaculture in China, *Wang Yianliang*
4. Sub-Saharan African aquaculture, Cecil Machena, John F. Moehl, Jr, A.G. Coche, V.O. Sagua
5. Aquaculture status and development trends in Latin America and the Caribbean, *Cesar Alceste-Oliviero and Manuel Martinez-Espinosa*
6. Aquaculture status and development trends in Near East countries, *Abdel El Gamal*
7. North American review on trends in aquaculture development, *Paul G. Olin*
8. Aquaculture development trends in the former USSR countries, *Laszlo Varadi, Sergey Blokhin, Ferenc Pekar, Istvan Szucs and Imre Csavas*
9. Aquaculture development trends in Europe, *Laszlo Varadi, Istvan Szucs, Ferenc Pekar, Sergey Blokhin and Imre Csavas*

C. Global review

1. A global perspective of aquaculture in the new millennium, *Sena S. de Silva*

D. Plenary lectures

1. Policy-making and planning for aquaculture, *Ulf Wijkstrom*
2. Technologies for sustainable aquaculture development, *Patrick Sorgeloos*
3. Regional and inter-regional Cupertino for sustainable aquaculture development, *Lennox Hinds*
4. Human resource development for sustainable aquaculture development, *Sena S. de Silva, Michael J. Phillips, Sih Yang Sim and Zhou Xiaowei*
5. Aquaculture and trade, *Helga Josupeit and Audun Lem*
6. Livestock production: a model for aquaculture?, *Robert A. Swick and Michael C. Cremer*

E Thematic reviews

1. Increasing the contribution of aquaculture for food security and poverty alleviation, *Albert G. J. Tacon*
2. Integrating aquaculture into rural development in coastal and inland areas, Graham Haylor and *Simon Bland*
3. Involving stakeholders in policy-making, planning and management, *Sevaly Sen*
4. Promoting sustainable aquaculture through economic incentives, *Rolf Willmann and Dennis Bailly*

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5. Establishing legal institutional and regulatory frameworks for aquaculture development and management, *Annick Van Houtte*
6. Building the information base for aquaculture policy-making, planning and management, *Yong-ja Cho*
7. Aquaculture systems and species, *Harald Rosenthal*
8. Genetics in aquaculture development, *K. Mujimdar and R. Dunham*
9. Aquaculture health management, *Rohana Subasinghe, et al.*
10. Nutrition and feeding, *Sadasivam Kaushik and M. R. Hasan*
11. Culture-based fisheries and enhancement, *K. Lorenzen, et al.*
12. Systems approach to aquaculture management, *C. E. Boyd and M. J. Phillips*
13. Aquaculture products: quality, safety, marketing and trade, *Helga Josupeit and Audun Lem*
14. Aquaculture development: financing and institutional support, *Ron Zweig, et al.*

II. Technical and Experience Papers Contributed to the Conference

A. Policy-making and planning

1. Development of freshwater aquaculture in China, *Miao Weimin*
2. Overview of marine aquaculture sector in Greece: trends, research and development and environmental impact, *Alexis J. Conides, Philip Ammerman, Shane A. Hunter and Petrina Zouganelli*
3. Potential of marine fish farming in India, *Charles M. James*
4. India's shrimp aquaculture in the third millennium: challenges and opportunities, *N. Subba Rao*
5. Aquaculture in Pakistan, *Razia Sultana*
6. Fish farming in Turkey, *Prof. Dr. Attila Alpbaz, Yrd Doc. Dr. Aynur Lok, Ass. Bilge Koseler*
7. Shrimp culture in Khanh Hoa Province (South Central Vietnam): present state and perspective, *Le Duc Minh*
8. Policy, legislative and environmental issues in tuna farming in South Australia, *J. Carey, S. Gibbs, M. Khouri, A. Larwood, K. Mitchell, V. Nair, A. Peace, K. Satoguchi and M. Parnell*
9. The economic consequences of water degradation in Panguil Bay and the management of its fisheries resources, *Elvira Ynion Adan*
10. Roles of stakeholders in policy-making, planning and management of aquaculture in Nigeria in the third millennium, *Adebayo O.T.*
11. A model for aquaculture development in Western Australia, *Peter P. Rogers*
12. Scaling-up and sustaining rice-fish culture activity in Bangladesh, *M.C. Nandeesha and Greg Chapman*
13. Sustainable aquaculture: a panacea for food security, poverty alleviation and rural development in Nigeria, *L.C. Nwanna*
14. New opportunities in pond fish farming, with special regard to Central and Eastern Europe – an economic approach, *Istvan Szucs and Andras Nabradi*
15. Environmental (fisheries) impact assessment of the rivers Padma-Kumar Project (Bangladesh), *M. Shafi*
16. Promotion of self help and sustainable inland fishery development: a case study from Sri Lanka, *L. Joseph, K. Perera, M. Waltemath and B. Schirm*

17. Small-scale aquaculture development in the Mekong Delta of Vietnam: preliminary results of the monitoring of the farmer-managed on-farm trials, *Pham Thi Bic Thong, Nguyen Thi Mui and Zsigmond Jeney*

B. Technology

18. Small-scale aquaculture development in the Mekong Delta of Cambodia: preliminary results of using GIS in identifying areas with potential for small-scale pond aquaculture development, Development of an *in vitro* primary cell culture system from haemocytes of *Macrobrachium nipponensis, Keo Sovanarry, Kaing Khim, Thay Somony, Bun Sopheak, Chhor Bunly, Zsigmond Jeney and Sununtar Setboonsang*
19. Development of an in vitro primary cell culture system from haemocytes of *Macrobrachoium nipponensis, Anli Wang, Junxia Wang, Weina Wang and Huican Guo*
20. Detection of white spot syndrome virus (WSSV) and Microsporidia mixed infection in frozen shrimp, and experimental infection in *Penaeus chinensis, Anli Wang, Fengchao Li, Weina Wang, Lei Sun, Mingshen Guo and Chunxia Yu*
21. Waste production trends in intensive cold-water fish farming, *Asbjorn Bergheim and Bjorn Btraaten*
22. Soil-system based approach for increasing fertilizer use efficiency in aquaculture, *G.N. Chattopadhyay, Soma Neogy, R. Mukherjee and K.N. Tiwari*
23. Management of fish-pond soil for increased production: a case study, *G.N. Chattopadhyay, Soma Neogy, Rajarsi Mukherjee and K.N. Tiwan*
24. Trout fish culture in irrigation reservoirs in Iran, *Ali Noorbakhsh and Kourosh Mohammadi*
25. A recirculating aquaculture system for the production of marine prawns, *R. Mohan*
26. The genetic impacts of introduced species and hatchery stocks on aquatic biodiversity in Thailand, *Uthairat Na-Nakorn and Supawadee Poompuang*
27. Role of recirculating system in the optimisation of stocking density of larvae of *Labeo rohita* and *Cirrhinus mrigala, Jaigopal Sharma and Rina Chakrabarti*
28. Effects of live-food and refrigerated-plankton food on the growth performance of *Catla catla* larvae, *Jaigopal Sharma and Rina Chakrabarti*
29. Bio-technology for intensive marine shrimp farming, *Siri Tookwinas*
30. Viable technique for hatchery seed production of giant freshwater prawn, *Macrobrachium rosenbergii* (de Man) through recirculation of natural sea water in inland states, *S.K. Upadhyay*
31. Evaluation of low-cost diets for growth of giant freshwater prawn (*Macrobrachium rosenbergii* (de Man) under monoculture and polyculture system, *S.K. Upadhyay, P. Shrivastava, and A. Swarup*
32. Dietary effectiveness of *Streptocephalus dichotomus* and *Artemia parthenogenetica* nauplii for rearing of *Macrobrachium rosenbergii* postlarvae, *C.S. Velu and N. Munuswamy*
33. A freshwater ecosystem model for trophic efficiency increase: Black Sea salmon in rural Crimea, *M.Y. Aleyev*
34. Rematuration and spawning of used wild spawners of *Penaeus monodon* in captivity, *N.G. Das and M.K. Alam*
35. The sustainability of fish cage farming in Southeast Asia, *Rafael D. Guerrero III*
36. Prospects and constraints in the adoption of freshwater prawn farming technology in India, *J. Stephen Sampath Kumar and V. Sundararaj*
37. Recommendations for improving the ecological functionality and cost effectiveness of disused shrimp aquaculture pond restoration back to mangrove forests, *Roy R. Lewis III*

38. Genetic research in the development of aquaculture with reference to India, *P.V.G.K. Reddy*
39. Visual light and magnetic field treatment applications in trout aquaculture: effects on reproduction in cultivated salmon (*Oncorhynchus mykiss*) in Crimea, *Victoria N. Radchenko*
40. Growth and survival of six stocks of rohu (*Labeo rohita*) in mono- and polyculture production systems, *P.V.G.K. Reddy, B. Gjerde, S.D. Tripathi, R.K. Jana, K.D. Mahapatra, S.D. Gupta, J.N. Saha, S. Lenka, P. Govindassamy, M. Rye and T. Gjedrem*
41. Effect of the probiotic Wunapuo-15 on three species of marine *Vibrio*: *Vibrio damsela, V. fluvialis* and *V. furnissiic, G. Sargunar, B. Vaseeharan and P. Ramasamy*
42. Achieving sustainable high yields in shrimp pond-culture using water recycling and ozone treatment, *W. Blogoslawski, A. Schuur, C. Strong, C. Perez, M. Hunter*
43. Characterisation of neurosecretory cells in the green-shelled mussel, *Perna canaliculus*, and their relationship with gonad development, *S. Mahmud and P.V. Mladenov*
44. Recent trends in freshwater aquaculture in Tamil Nadu (India), *V. Sundararaj and J. Stephen Sampath Kumar*
45. Effects of different culture techniques on growth, survival and production of giant freshwater prawn (*Macrobrachium rosenbergii* (de Man)), *S.K. Upahyay, A. Swaroop and S.N. Dwivedi*
46. Water quality in extensive and semi-intensive shrimp ponds in Bangladesh, *M.A. Wahab, B. Braaten and A. Bergheim*
47. The effects of zinc in the seawater environment on the amino acid contents in the muscle of *Penaeus chinensis, Wang Weina, Wang Anli, Wang Jianping, Sun Ruyong*
48. The brackish water Acadja systems in West African lagoons, *Philippe A. Laleye and Jacques Moreau*
49. Fish-culture based fisheries in small reservoirs in the Sahelian Region. *Jacques Moreau*
50. Genetic researches with Mytilus from the Black Sea, *A.V. Pirkova and V.N. Ivanov*
51. Biodiversity utilisation in aquaculture – concept and calculated crude indices, *M.N. Kutty*
52. Seafarming development in the Philippines, *Salvacion Ferrer*

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3.10 Annex 10: Bangkok Declaration and Strategy for Aquaculture Development Beyond 2000

1 PREAMBLE

The first international Conference on Aquaculture organised by the Food and Agriculture Organization of the United Nations (FAO) was held in Kyoto, Japan in 1976. The Conference adopted the "Kyoto Declaration on Aquaculture."

In February 2000, some 540 participants from 66 countries participated in the "Conference on Aquaculture in the Third Millennium" in Bangkok, Thailand. This Conference was organised by the Network of Aquaculture Centres in Asia-Pacific (NACA) and the FAO and hosted by the Government of Thailand.

Throughout 1999, NACA and the FAO facilitated the preparation of reviews on aquaculture developments in Africa, Asia, Europe, Latin America, North America, the countries of the former USSR, the Near East, and the Pacific Island nations and held expert meetings to consider trends in aquaculture development. Thematic Reviews on various aspects of aquaculture were also conducted. Participants to the Bangkok Conference were informed of the findings and conclusions of these activities.

Against this background, the Conference participants discussed strategies for the development of aquaculture for the next two decades, in the light of the future economic, social and environmental issues and advances in aquaculture technologies.

Based on these deliberations, the participants to the Conference adopted the following Declaration.

2 THE DECLARATION

We, the participants to the Conference on Aquaculture in the Third Millennium, Bangkok 2000, recognise that:

2.1 during the past three decades aquaculture has become the fastest growing food-producing sector and is an increasingly important contributor to national economic development, the global food supply and food security;

2.2 aquaculture consists of a broad spectrum of users, systems, practices and species, operating through a continuum ranging from backyard household ponds to large-scale industrial systems;

2.3 the per caput supply of food fish from capture fisheries is likely to decline with population increase;

2.4 a great proportion of aquaculture production comes from developing countries, where aquaculture will continue to contribute to peoples' livelihoods, food security, poverty alleviation, income generation, employment and trade;

2.5 there has been a significant increase in commercial and industrial aquaculture, both in developed and developing countries, that has contributed to food supply, export income and trade;

2.6 globally, aquaculture is at varying stages of development and will require different strategies for growth;

2.7 the potential of aquaculture to contribute to food production has not yet been realised across all continents;

2.8 aquaculture complements other food production systems, and integrated aquaculture can add value to the current use of on-farm resources;

2.9 aquaculture can be an entry point for improving livelihoods, planning natural resource use and contributing to environmental enhancement;

2.10 responsible aquaculture practitioners are legitimate users of resources;

2.11 education and research will continue to make a significant contribution to the growth of aquaculture;

2.12 some poorly planned and managed aquaculture operations have resulted in negative impacts on ecosystems and communities;

2.13 aquaculture has also been negatively impacted by other unplanned activities;

2.14 the continued growth of aquaculture will occur through investment by the private and public sectors;

2.15 effective national institutional arrangements and capacity, policy, planning and regulatory frameworks in aquaculture and other relevant sectors are essential to support aquaculture development;

2.16 improving co-operation amongst stakeholders at national, regional and inter-regional levels is pivotal for further development of aquaculture;

2.17 the potential of aquaculture to contribute to human development and social empowerment cannot be fully realised without consistent, responsible policies and goals that encourage sustainable development;

and declare that:

2.18 the aquaculture sector should continue to be developed towards its full potential, making a net contribution to global food availability, household food security, economic growth, trade and improved living standards;

2.19 the practice of aquaculture should be pursued as an integral component of development, contributing towards sustainable livelihoods for poor sectors of the community, promoting human development and enhancing social well-being;

2.20 aquaculture policies and regulations should promote practical and economically viable farming and management practices that are environmentally responsible and socially acceptable;

2.21 national aquaculture development processes should be transparent and should take place within the framework of relevant national policies, regional and international agreements, treaties and conventions;

2.22 in pursuing development, States, the private sector, and other legitimate stakeholders should co-operate to promote the responsible growth of aquaculture;

2.23 strengthened regional and inter-regional co-operation should increase the efficiency and effectiveness of aquaculture development efforts; and

2.24 all parties formulating improved policies and implementing practices for aquaculture development should consider and where appropriate, build on the FAO Code of Conduct for Responsible Fisheries.

The following contains the major strategy elements based on the Conference session recommendations. The detailed recommendations from the sessions are given in the Conference Report.

3 STRATEGY FOR AQUACULTURE DEVELOPMENT BEYOND 2000

States are encouraged to incorporate in their strategies for aquaculture development the key elements identified during this Conference.

The key elements are:

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3.1 INVESTING IN PEOPLE THROUGH EDUCATION AND TRAINING

Further investments in education and training are essential to build the knowledge, skills and attitude of all people involved in the sector. Human capacity development can be made more cost-effective and responsive to needs through:

- using participatory approaches to curriculum development;
- improving co-operation and networking between agencies and institutions;
- multidisciplinary and problem-based approaches to learning;
- use of modern training, education and communication tools, such as the Internet and distance learning, to promote regional and inter-regional co-operation and networking in the development of curricula, exchange of experiences and development of supporting knowledge bases and resource materials; and
- providing a balance of practical and theoretical approaches to train farmers and provide more skilful and innovative staff to industry.

3.2 INVESTING IN RESEARCH AND DEVELOPMENT

There is a need to increase investment in aquaculture research, whilst making efficient use of research resources and building the capacity of research institutions to be more responsive to development requirements through such mechanisms as:

- collaborative multidisciplinary research;
- stakeholder participation in research identification and implementation;
- improving linkages between research, extension and producers;
- collaborative funding arrangements between institutions and public and private sector organisations;
- efficient communication networks;
- regional and inter-regional co-operation; and
- a continued effort to build the skills of researchers involved in aquaculture development.

3.3 IMPROVING INFORMATION FLOW AND COMMUNICATION

Efficient management of the sector requires improved information flows at the national, regional and inter-regional levels which will avoid duplication of effort and save costs, while encouraging consistency in areas such as education and training, policy-making, planning and the application of rules and procedures.

Improved information flows will increase institutional capacities for dealing with emerging issues and can be achieved by:

- establishing arrangements for sharing data and information;
- strengthening national capacity to determine data requirements and data selection and management;
- providing effective mechanisms for access to relevant and reliable information to all stakeholders; and
- making effective use of new technologies to improve information flows and management policies and practices within aquaculture.

The collection and dissemination of accurate and verifiable information on aquaculture may help to improve its public image and should be given attention.

3.4 IMPROVING FOOD SECURITY AND ALLEVIATING POVERTY

Enhancing food security and alleviating poverty are major and complementary global priorities. Aquaculture has a special role in achieving these objectives because, firstly, fish is a highly nutritious food that forms an essential, if not indispensable, part of the diet of a large proportion of the people in developing countries. Secondly, while aquaculture contributes to the livelihoods of poor farming households, particularly in areas of Asia where it is a traditional farming practice, there is a huge, unfulfilled potential in most countries, as aquaculture is a relatively recent and underdeveloped sector as compared to agriculture and animal husbandry. Aquaculture could improve food security, provide entry points and contribute to sustainable livelihoods for the poor through:

- promoting poor-people-centred development focus in aquaculture sector policies, wherever appropriate;
- promoting systems to farm low-value fish affordable to the poor, particularly small-scale household production in rural areas where it may be the only source of fish due to poor infrastructure;
- disseminating information about the nutritional advantages of fish to vulnerable groups of people such as pregnant and lactating women, and families with infants and pre-school children;
- greater use of holistic, participatory approaches to identify the poor and assess their needs; and to develop and extend aquaculture technologies appropriate to the resources and capabilities of poor households;
- recognising that the development of small-scale aquaculture requires initial public sector support, with more support needed and for longer periods for poorer target groups; and
- empowering poor stakeholders to actively participate in policy decision-making.

3.5 IMPROVING ENVIRONMENTAL SUSTAINABILITY

There is a need to develop and adopt policies and practices that ensure environmental sustainability, including environmentally sound technologies and resource efficient farming systems, and integration of aquafarms into coastal area and inland watershed management plans. Improvements in environmental sustainability can be achieved through:

- development, adoption and application of environmental, economic and social sustainability assessment criteria and indicators of aquaculture development;
- development of and support to implementation of improved management practices and codes of good practice for aquaculture sectors that are supported by enforceable regulations and policy;
- research and development of resource-efficient farming systems which make efficient use of water, land, seed and feed inputs; exploring the potential for commercial use of species feeding low in the food chain; and utilising enhancement techniques;
- development of strategies to integrate aquaculture into the coastal areas and inland watershed management plans and ensuring aquaculture developments are within local and regional carrying capacities;
- promotion of good practices for environmental management of aquaculture; and
- promotion of aquaculture, where appropriate, as a means of improving environmental quality and resource use.

3.6 INTEGRATING AQUACULTURE INTO RURAL DEVELOPMENT

With the goal of increasing the impact of aquaculture on rural development and poverty alleviation, strategies are required to put people as the focal point for planning and development for such programmes and to integrate aquaculture into overall rural development programmes. In essence, this can be achieved through:

- integrating aquaculture planning within overall rural development planning, taking into account multi-sectoral developments and views, and multi-sectoral co-ordination which brings agencies together;
- integrating aquaculture with other rural development efforts to improve resource utilisation, such as integrated coastal area management and inland watershed management;
- awareness-raising in other rural development sectors of the potential of aquaculture to improve livelihoods;
- using participatory approaches to involve stakeholders in policy-making, planning, implementation and monitoring; and
- the documentation and wide dissemination of information on experiences and utilisation of good practices and benefits thereof.

3.7 INVESTING IN AQUACULTURE DEVELOPMENT

Future investment in aquaculture should be made with long-term strategies in mind to ensure sustainability. Private sector investments make the biggest contribution to aquaculture development, but adequate public sector finance for capacity building, institutional development and infrastructure, is indispensable for society to reap the full benefits of a well managed and efficient aquaculture sector.

Sound investment strategies should include:

- providing initial financial encouragement and facilitating investments in aquaculture development;
- encouraging continued public investment in rural and small-scale aquaculture in developing countries, and in applied research and farmer access to knowledge and capital;
- encouraging private sector funding and investment in aquaculture development and infrastructure which will provide the benefits of aquaculture to rural communities;
- developing mechanisms (e.g., investment screens, credit linked to performance or adoption of best management practices, performance bonds) which encourage the growth of environmentally and socially responsible aquaculture, including economic, educational and other incentives for responsible aquaculture;
- support to sponsorship of industry-driven codes of practice to promote responsible aquaculture;
- fostering a greater understanding within financial institutions and bilateral and multilateral assistance agencies regarding aquaculture development and its financial needs; and
- establishing credit schemes that support sustainable aquaculture, e.g., micro-credit programmes, particularly for small-scale development.

International development assistance is becoming increasingly directed towards poverty alleviation and needs to adhere to basic principles of social equity, including gender equity, environmental sustainability, technical feasibility, economic viability and good governance. The level of risk is important when supporting initiatives to address poverty alleviation.

To make efficient use of international donor resources, a programme approach to multi-sectoral development should be applied under which donors can more effectively co-operate and collaborate with each other. Ultimately, this should occur within comprehensive planning and development frameworks. There is thus a need for donors to adopt more cohesive approaches and procedures.

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3.8 STRENGTHENING INSTITUTIONAL SUPPORT

One of the key issues for the growth of aquaculture will be the ability of countries and organisations to strengthen their institutional capacity to establish and implement policy and regulatory frameworks that are both transparent and enforceable. Incentives, especially economic incentives, deserve to be given more attention in the planning and management of aquaculture development.

Institutional capacity should be made more effective and strengthened through:

- developing a clear aquaculture policy, and identification of a lead agency with adequate organisational stature to play a strong co-ordinating role;
- developing, through a participatory approach, comprehensive and enforceable laws, regulations and administrative procedures that encourage sustainable aquaculture and promote trade in aquaculture products;
- providing education and training, research and extension services to support the development of enforceable legislation, policy and regulatory frameworks, encompassing economic and other incentives to improve aquaculture management;
- targeting not only government ministries and public sector agencies dealing with administration, education, research and development, but also organisations and institutions representing the private sector, NGOs, consumers and other stakeholders;
- developing mechanisms and protocols for the timely collection and reporting of statistics;
- sharing information on policies and legislation, rules and procedures that encompass best practices in aquaculture;
- clarifying legal frameworks and policy objectives regarding access and user rights for farmers; and
- improving the capacity of institutions to develop and implement strategies targeting poor people.

3.9 APPLYING INNOVATIONS IN AQUACULTURE

The technologies for sustainable aquaculture development should provide a varied and adaptable "tool box" from which people can select and design the system which most effectively meets their needs and best fits the opportunities and constraints of the local environment. The delivery of such techniques requires efficient communication networks, reliable data on the merits and drawbacks of the various approaches, and help with the decision making process through which people choose their production systems and species.

As we move into the next two decades, water and land for aquaculture will become critical issues. New opportunities for aquaculture development will also emerge through improvements in science and technology for aquaculture systems.

The potential areas for further consideration include:

- technologies for sustainable stock enhancement and ranching programmes, and open ocean aquaculture;
- increased use of aquatic plants and animals as nutrient stripping;
- increased emphasis on integrated systems to improve environmental performance; and
- emerging technologies (e.g., recirculating systems, offshore cage culture, integrated water use, artificial upwelling and ecosystem food web management).

3.10 IMPROVING CULTURE-BASED FISHERIES AND ENHANCEMENTS

Fisheries enhancements in inland and coastal waters include culture-based fisheries and habitat modifications in common pool aquatic resources, which require minimal food and energy inputs.

These practices therefore provide important opportunities for resource poor sections of the population to benefit from relevant aquaculture technologies and permit efficient use of under-utilised, new or degraded resources. Culture-based fisheries in particular have considerable potential for increasing fish supplies from both freshwater and marine fisheries and generating income in rural inland and coastal areas.

The full potential of enhancements and culture-based fisheries could be achieved by:

- creating conducive institutional arrangements to enable and sustain investment in common pool resources;
- providing appropriate research and development inputs;
- managing environmental and other external impacts; and
- promoting effective regional co-operation and information exchange.

3.11 MANAGING AQUATIC ANIMAL HEALTH

Disease is currently an important constraint to aquaculture growth which has impacted both socio-economic development and rural livelihoods in some countries. Addressing aquatic animal health issues has, therefore, become an urgent requirement for sustaining growth of aquaculture, especially through pro-active programmes. Harmonising health protection approaches and measures and effective co-operation at national, regional and inter-regional levels are needed to maximise the effectiveness of limited resources.

This can be achieved through:

- developing, harmonising and enforcing appropriate and effective national, regional and inter-regional policies and regulatory frameworks on introduction and movement of live aquatic animals and products to reduce the risks of introduction, establishment and spread of aquatic animal pathogens and resulting impacts on aquatic biodiversity;
- capacity building at both the institutional and farmer levels through education and extension;
- developing and implementing effective national disease reporting systems, databases, and other mechanisms for collecting and analysing aquatic animal disease information;
- improving technology through research to develop, standardise and validate accurate and sensitive diagnostic methods, safe therapeutants, and effective disease control methodologies, and through studies into emerging diseases and pathogens;
- promoting a holistic systems approach to aquatic animal health management, emphasising preventative measures and maintaining a healthy culture environment; and
- developing alternate health management strategies such as the use of disease resistant, domesticated strains of aquatic animals to reduce impact of diseases.
- Establishment of an effective international mechanism, such as an international task force which is outcome-oriented with focused strategies and milestones that are independent of vested interests, would be beneficial in reducing the losses due to diseases in aquaculture.

3.12 IMPROVING NUTRITION IN AQUACULTURE

Nutrition and feeding strategies play a central and essential role in the sustainable development of the aquaculture sector. Feed development will need to give increased emphasis on efficient use of resources and reduction of feed waste and nutrient discharge. Fishmeal reduction in diets will be important to reduce feed costs and avoid competition with other users.

These can be achieved through:

- increasing the understanding of dietary nutrient requirements of cultured species, including their application to practical culture conditions;

- developing species-specific broodstock diets that allow complete domestication and maximal reproductivity and larval quality;
- better understanding of larval nutritional requirements in order to develop suitable compound diets, which will further reduce the need for live food;
- improving the understanding of the aquaculture farming systems and the potential nutrient loads and losses to the environment, to maximise nutrient retention efficiency;
- improving the use of agricultural and fishery by-products and non-food grade feed materials, and basing feeding strategies, wherever possible, on the use of renewable feed ingredient sources;
- better understanding of nutrient bioavailability and interactions of commonly used feed ingredients;
- better understanding of the mechanisms of nutrient modulation of disease resistance as well as improved strategies to minimise toxicity of nutrients and other compounds of feed origin;
- promotion of "good aquaculture feed manufacturing practice" and "good on-farm feed management;" and
- ensuring that limitations in the selection and trade of raw materials for aquaculture feeds are based on sound, documented scientific facts.

3.13 APPLYING GENETICS TO AQUACULTURE

Genetics has an important role to play in increasing productivity and sustainability in aquaculture through higher survival, increased turnover rate, better use of resources, reduced production costs and environmental protection. This will require resources, but the benefits in both the short and long term should justify these efforts.

There are many elements and practices of genetics that may be considered for aquaculture. Recognising that aquaculture has not benefited as much as terrestrial animal husbandry from the adoption of best practices such as selective breeding and stock improvement programmes, high priority should be given to the application of genetics in aquaculture. The interventions include:

- developing and utilising improved domestication and broodstock management practices and efficient breeding plans to improve production in aquatic animals;
- designing and promoting strategies for equitable dissemination of genetic techniques and genetically improved organisms;
- encouraging public awareness and providing information to consumers on the application of genetics;
- greater application of genetic technologies to the conservation of aquatic biodiversity; and
- addressing the potential implications for aquaculture, including environmental and human health implications, in a precautionary, safe and practical way.

3.14 APPLYING BIOTECHNOLOGY

Biotechnology as a science has the potential to impact on all food production sectors. In the future the aquaculture sector will confront the issue of biotechnology through:

- developing and applying biotechnological innovations for advances in nutrition, genetics, health, and environmental management;
- addressing the potential implications for aquaculture of biotechnology, including GMOs and other products, in a precautionary, safe and practical way; and
- encouraging public awareness and providing information to consumers on the potential applications of biotechnology.

3.15 IMPROVING FOOD QUALITY AND SAFETY

As consumer awareness increases, aquaculture producers, suppliers and processors will need to improve the quality of products and enhance product safety and nutritional value. The incentives for this will be potentially higher prices, lower insurance rates and increased consumer demand.

This can be achieved through:

- improvements in diets, feeding regimes and harvesting strategies to enhance product quality and nutritional value of aquaculture products;
- promoting the application and adoption of international food safety standards, protocols and quality systems in line with international requirements such as the Codex Alimentarius;
- adopting international protocols for residue monitoring in aquaculture and fisheries products;
- appropriate and informative labelling of aquaculture feeds, including information on additives, growth promoters and other ingredients.
- collection, analysis and dissemination of relevant and scientifically sound information to allow producers and industry operators to make informed decisions and ensure consumer confidence in the food safety of aquaculture products;
- application of appropriate safety assessments based on risk analysis and the precautionary approach prior to market approval, including products from modern biotechnology; and
- increasing consumer confidence in aquaculture products by ensuring that industry takes responsibility for the production and distribution of safe products, utilising systems that allow traceability of product ingredients, including information on packaging, processing and production conditions.

3.16 PROMOTING MARKET DEVELOPMENT AND TRADE

A focus on market development and trade will increase demand, add value and increase returns for aquaculture products. This will require developing marketing and promotional strategies for aquaculture products and understanding consumer requirements and changing market demands.

These goals can be achieved through:

- reducing trade barriers for aquatic products;
- assisting producers, processors and manufacturers in identifying markets for aquaculture inputs, products and technology;
- providing data for, and investing in, information-technology based market-information systems that are easily accessed by producers and processors;
- researching changing consumption patterns, market segmentation trends and the emergence of new markets and products; and
- ensuring transparency in the chain of custody ("chain traceability") of aquatic products and encouraging the provision of relevant information to consumers through product labelling (e.g., nutritional values, environmental friendliness).

3.17 SUPPORTING STRONG REGIONAL AND INTER-REGIONAL CO-OPERATION

Over the years, regional and inter-regional co-operation has brought considerable benefits to aquaculture development through dissemination of knowledge and expertise. In an era of globalisation, further strengthening of this co-operation at all levels will ensure increased benefits for sectoral development and sustainability.

This could be achieved through:

- supporting and strengthening existing regional organisations;

- improving inter-regional collaboration and networking between existing regional organisations to ensure synergy;
- encouraging the formation and development of regional organisations for aquaculture development in regions where they are lacking; and
- facilitating in-country support for the establishment and operation of these organisations.

The Conference noted there are issues relevant to aquaculture development that require a strong global focus to be addressed and that this need might best be achieved by establishing a global intergovernmental forum within an appropriate existing international organisation, having sustainable aquaculture development as its primary focus, and with a mandate for discussion, decision and agreement on technical and policy matters.

4 IMPLEMENTATION

4.1 The Conference encourages States, the private sector and other concerned organisations to implement Strategies for Development of Aquaculture Beyond 2000.

4.2 The aquaculture sector has become considerably more diverse since the Kyoto Conference and has developed a broad range of stakeholders. This diversity provides considerable opportunity for productive co-operation.

4.3 The Conference recognises that the primary responsibilities for development and implementation of these strategies rest with States and their private sectors. The Conference recommends that States develop strategies through encouraging private sector development incorporating the key elements identified above.

4.4 The Conference further affirms that co-operative mechanisms among countries provide an excellent opportunity to co-ordinate and support the development of aquaculture, through sharing of experiences, technical support, and allocation of responsibilities for the varied research, education and information exchange. The fostering of co-operation among developing countries deserves special attention and support.

4.5 Furthermore, the Conference recommends that effective use of existing regional and inter-regional mechanisms be made, and that decision-makers seek to promote synergy and co-operation between existing organisations. Where effective regional inter-governmental organisations to promote co-operation in aquaculture development do not exist, such as in Africa and Latin America, building of such mechanisms, and sharing experiences with the existing regional networks, is recommended.

4.6 The Conference notes that there are considerable opportunities for enhanced regional and inter-regional co-operation among different partners including governments, non-governmental organisations, farmers organisations, regional and international organisations, development agencies, donors and lending agencies with a common interest in development through aquaculture.

4.7 In this regard, the Conference strongly recommends the development of an effective programme of regional and inter-regional co-operation to assist in implementation of the Strategies for Aquaculture Development Beyond 2000.

The Declaration and Strategy was drafted by a Technical Drafting Committee (TDC), taking into account the recommendations of all conference sessions, and the views and suggestions expressed by the participants during and after the Conference. The composition of the TDC is: Glenn Hurry and Chen Foo Yan (Co-Chairs), Uwe Barg, Pedro Bueno, Jorge Calderon, Jason Clay, Sena De Silva, Maitree Duangsawasdi, Dilip Kumar, Le Thanh Luu, Modadugu V. Gupta, Joaquin Orrantia, Michael Phillips, Rolando Platon, Vincent Sagua, Sevaly Sen, Patrick Sorgeloos, Rohana Subasinghe, Rolf Willmann, and Wu Chao Lin.

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The Conference on Aquaculture in the Third Millennium was held on 20-25 February 2000 in Bangkok, Thailand, for the purpose of developing a strategy for aquaculture development in the next 20 years. It was a sequel to the Kyoto Conference on Aquaculture, which was organized by FAO in May-June 1976. The Bangkok Conference was attended by 549 participants representing all stakeholder groups in aquaculture. The participants were members of more than 200 organizations and came from 66 countries in Asia, Africa, Latin America and the Caribbean, Europe, the former Soviet Republics, the Near East, North America and Oceania. The list of participants appears as Annex 3.1.

The Bangkok Conference crafted the document *Aquaculture development beyond 2000: the Bangkok Declaration and Strategy*, which has been published separately by the Network of Aquaculture Centres in Asia-Pacific (NACA) and FAO. The Declaration addresses the role of aquaculture in alleviating rural poverty, improving livelihoods and food security, and maintaining the integrity of natural and biological resources and the sustainability of the environment. The Strategy comprises 17 elements that focus on measures that governments, the private sector and other concerned organizations can incorporate into their development programmes for the aquaculture sector. It highlights the need for regional and interregional cooperation to assist in its implementation.

This report of the Bangkok Conference on Aquaculture, the second publication arising from the Millennium Conference, includes the detailed recommendations of the 14 thematic conference sessions. The third publication will be the technical proceedings of the Bangkok Conference.

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